Computer Controlled Power Supply, Pt.1

# SILICON CHIP

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AUSTRALIA'S DYNAMIC ELECTRONICS MAGAZINE

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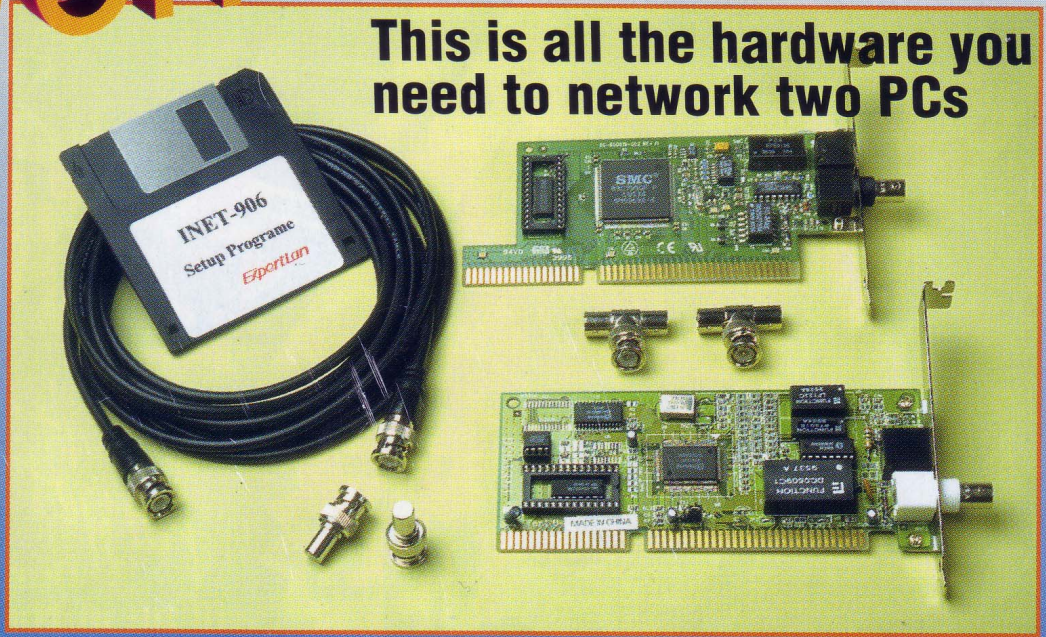


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Control Panel For Multiple Smoke Alarms

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# PUBLISHER'S LETTER

## Putting those old computers to work

This month we have three computer-related articles which emphasise the usefulness of older computers. The first is the article on networking, starting on page 4. This was prompted by an application in our office but is typical of situations which occur in small offices or homes with more than one computer. It is a boon when printing from more than one computer is a common requirement.

The second article is the computer controlled power supply which starts on page 56. This is an interesting project because it can be built as a conventional power supply or as one which is under full control of a computer. Such a supply can be turned on and off or the voltage varied automatically. As well, the current drain can be recorded, which could be useful in some applications.

The third article relates to the Digi-Temp which can monitor up to eight temperature sensors in different locations via two wires. Again, it can be built as a self-contained unit or it can be hooked up to a computer for logging applications. It starts on page 80. On the same theme, next month we will publish a computer controlled message board.

None of these applications require the latest Pentium-based machine but can use older 286, 386 or 486-based machines. They emphasise that the older machines still have a multitude of uses and don't need to gather dust in the back of a closet.

We are very conscious of the market pressures to upgrade computers, particularly with the advent of Windows 95 software which is so hungry for RAM and hard disc space. These pressures are bad enough in a commercial environment where it is almost mandatory to obtain the latest upgrades of every software package. Where it does seem unnecessary is with the tens of thousands of home machines which are seldom used to even a fraction of their potential.

This was driven home to me just recently concerning the computer of one of my close relatives. She has a 100MHz Pentium machine with a large hard disc, quad-speed CD ROM, sound card and all the bells and whistles. It is only 12 months old and the video monitor has just failed. However, instead of getting the monitor repaired, she is seriously considering replacing the system with a 166MHz Pentium machine, partly because she has had a few hassles with the Windows 95 setup and the sound card.

I was flabbergasted, as you can imagine. For probably less than $100 the monitor could be repaired and a few hours or so spent optimising the Windows 95 setup would be required to make it do all she could want. The difference in speed in upgrading to a 166MHz machine would be marginal – for much of the time it is merely used to play games. But she was being swayed by the market hype for the new machines. Such an outlook is extremely wasteful and yet all too common.

**Leo Simpson**

**WARNING!**

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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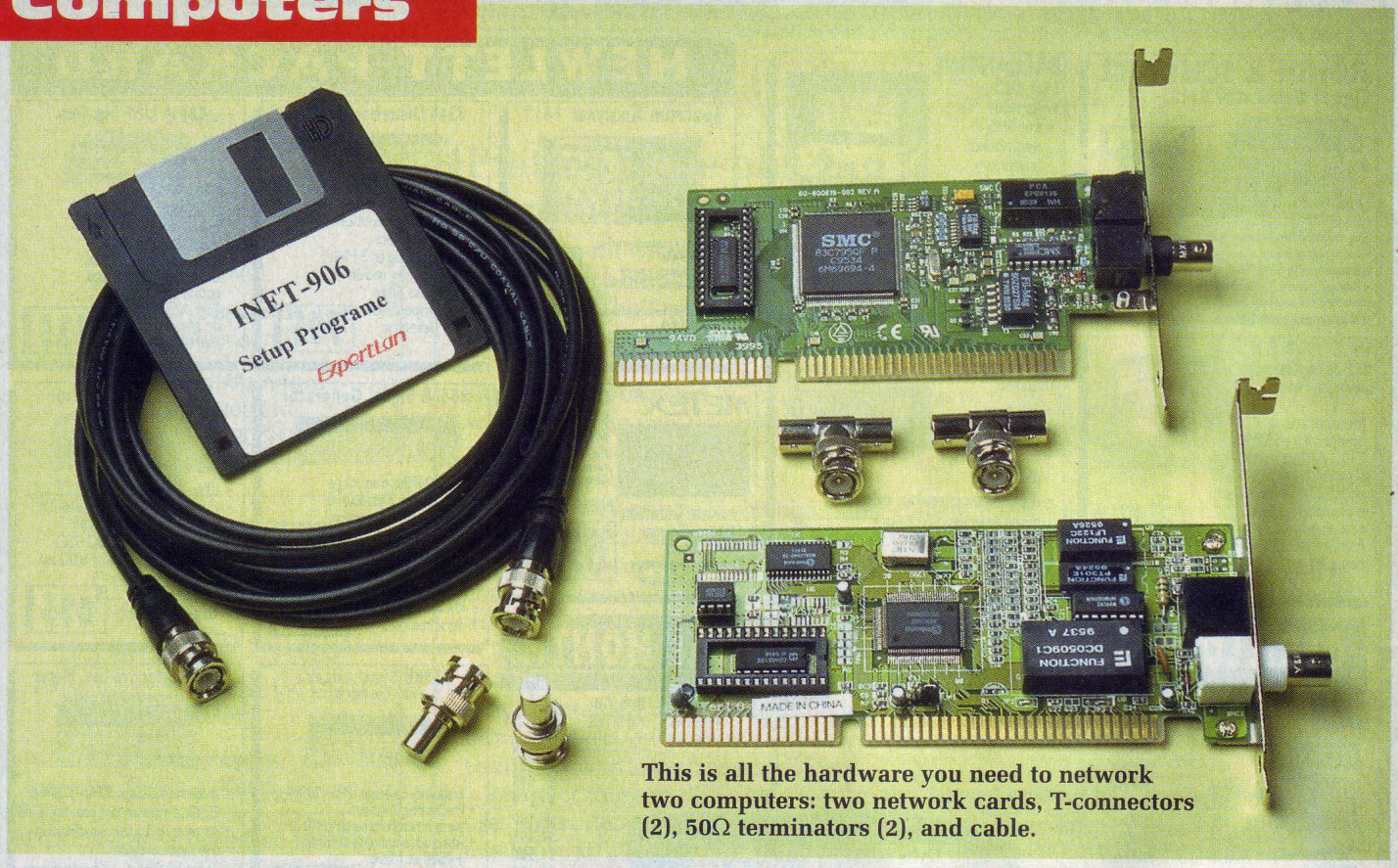



**This is all the hardware you need to network two computers: two network cards, T-connectors (2), 50Ω terminators (2), and cable.**

# Networking: it's easier than you think

## If you have two computers in your home or small business, why not network them? It's easy to do, doesn't cost much & has lots of benefits.

By GREG SWAIN

Many people now have two or more computers at home or as part of a small business. Typically, one machine will be an old 286 or 386 machine, while the other will be a 486 or even a Pentium machine with full multimedia capabilities.

Quite often, the older machine will have been pushed to one side and left unloved. As most people discover, it's not worth selling an old computer. It might have cost $2000 three years ago but it's not worth much today. It's a fact – no-one wants to buy an old clunker.

As a result, the old machine is no longer used or is relegated to a humble word processing role. But there's a lot more that you can do with an obsolete computer, as we shall see.

For the price of a couple of cheap network cards and a few metres of cable, you can connect your two machines together. This has a number of benefits, the most obvious being that you no longer have to "walk" floppy discs between machines to exchange files. In addition, networking can give each user access to the other computer's hard disc drive – very handy if you're running short of space.

Often, however, the older machine will be used as a file server or as a print server (or both). A "server" can generally be regarded as the central computer on a network, even though it might not be the most powerful computer in the group. Typically, it allows other users on the network to access common resources, such as a printer or files. In addition, users con-

nected to a network can share their own resources with others on the network. You have a lot of flexibility in setting up a network – it's your choice as to what you share and with whom.

You can even share different resources with different people. We won't get too complicated here, though. Instead, we'll confine ourselves to a simple two-computer network and show you how to install it and set it up.

## Network benefits

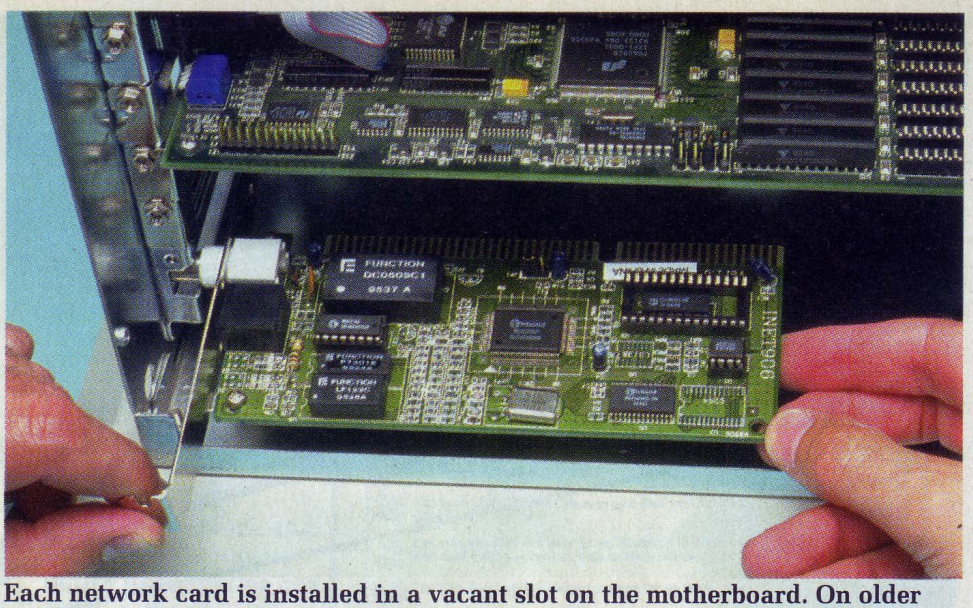
Using an otherwise obsolete computer as a printer server can be a great time saver. Basically, the printer is connected to the server and the print job quickly spools onto its hard disc when ever you print from the remote machine. The server then takes over the printing job while you get back to work.

If you do a lot of big printing jobs like mail merges or desktop publishing, the advantages of a print server will be obvious. You can quickly resume working on the new machine while the job is still printing.

Alternatively, if both machines are used by different members of the household or business, there's no argument over who gets the printer. Both can print jobs without swapping printer cables or unplugging and relocating the printer.

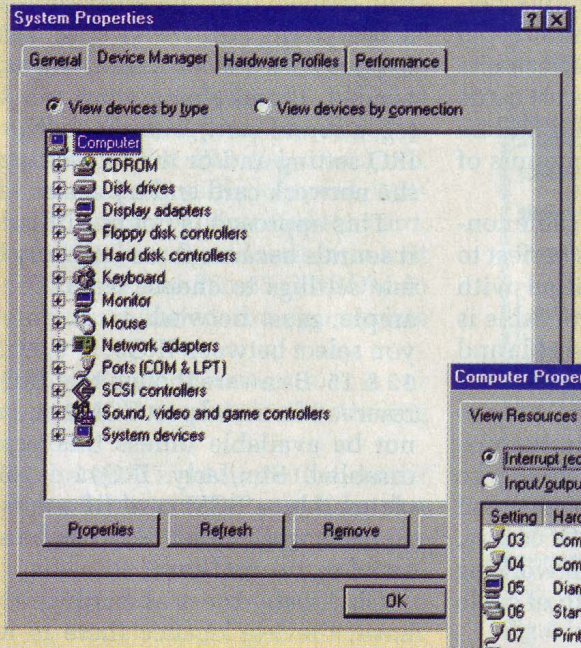
Using an old machine as a printer server can also be an advantage if your new machine runs Windows 95 and you are unable to obtain a suitable printer driver. This is sometimes the case with older printers which are now considered obsolete. The way around this problem is to use the existing Windows 3.11 printer driver on the old machine.

Another area where a network is an advantage is if you have a fax/modem. By fitting the fax/modem to the older



**Each network card is installed in a vacant slot on the motherboard. On older cards, you will need to check jumper settings before plugging the board in. Later cards are usually configured after installation using software.**

## Checking Resources In Windows 95



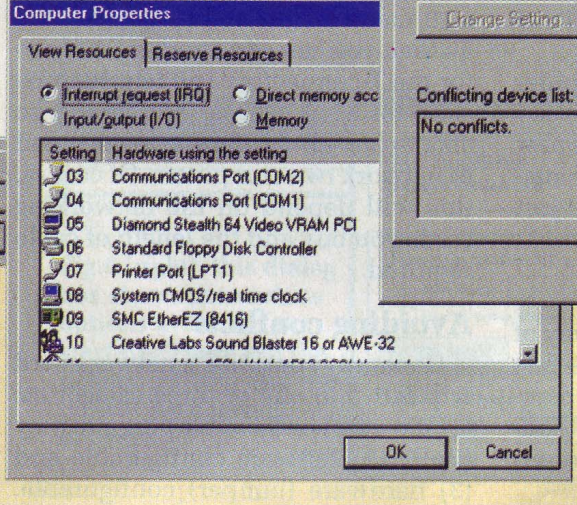




**Fig.1 (above) & Fig.2 (right): you can easily check on available system resources in Windows 95 by double-clicking the System icon in control panel, then clicking the Device Manager tab, selecting Computer and clicking Properties.**

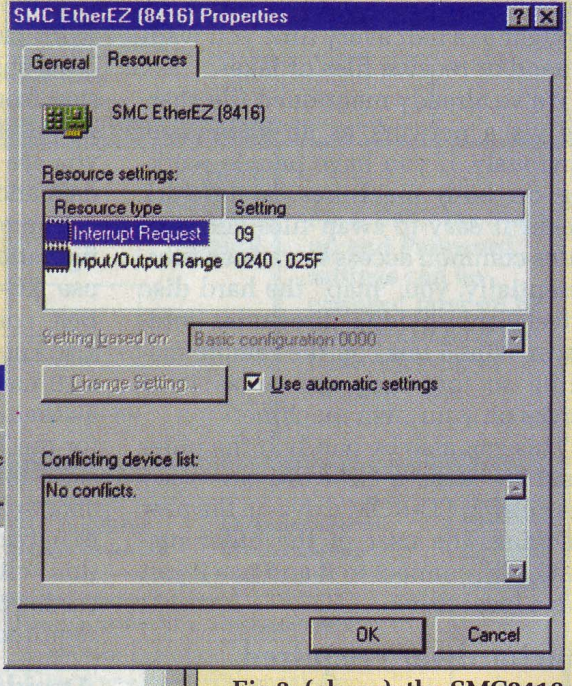
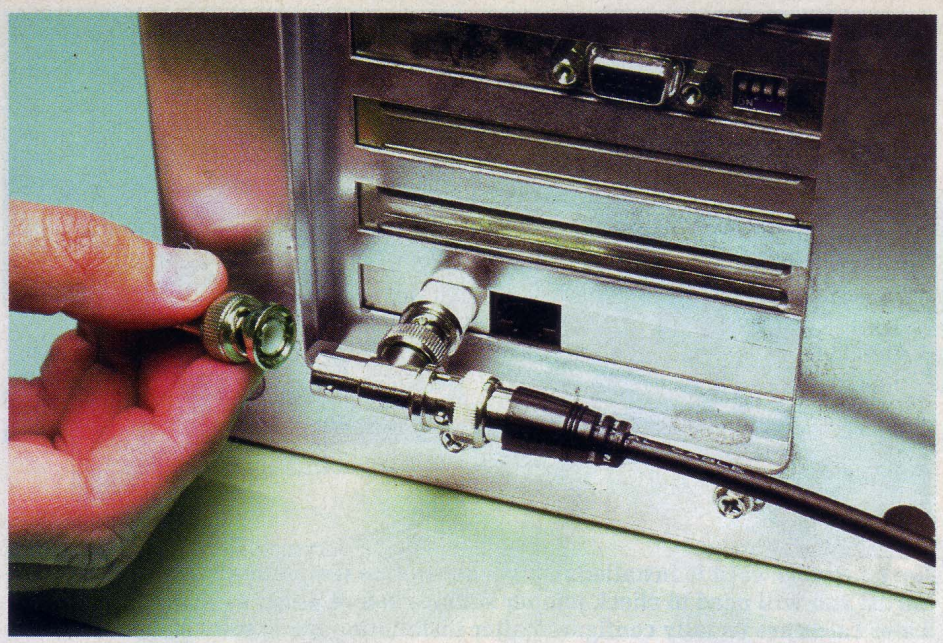
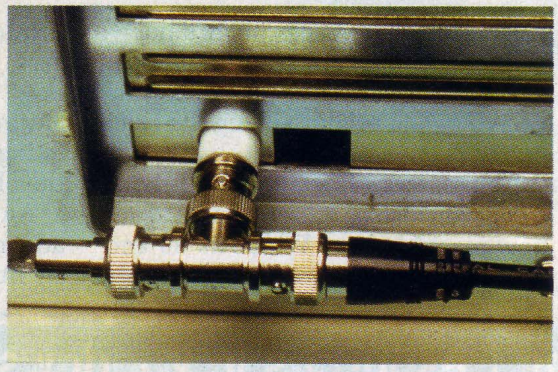



**Fig.3: (above): the SMC8416 card was a Plug and Play device and installed easily. If you get device conflicts, assign the resources manually using this dialog box.**





**The computers are connected by first fitting the T-connectors to the BNC sockets on the networks cards and then installing the coaxial cable. The open end of each T-connector is then fitted with a 50Ω terminator, as shown at right.**

machine, your work will not be brought to a halt every time you want to send or receive files or faxes.

We've already mentioned file sharing via a network as an advantage. Obviously, if you have people working on both machines, a network makes it easy to swap files and provides common access to various files. Essentially, you "map" the hard disc drive(s) or individual directories (folders in Win95 talk) on the remote machine so that they appear as local drives on your own machine.

This can also be handy if the older machine lacks a CD-ROM drive. By sharing the CD-ROM drive on the new machine, the user of the older machine can connect to it and use it just like a local drive.

## The hardware required

You don't need much in the way of hardware for a simple network – just two network cards (one for each computer), a network cable, two "T" connectors, and a couple of 50Ω terminators.

A typical NE2000-compatible network card (the most common type) costs about $50, although better units start from around $65. Low-cost cards will do for a basic installation, unless you are transferring large amounts of data and speed is important.

There are several types of cable configurations available but it's easiest to use RG-58 coaxial cable fitted with BNC connectors. This type of cable is also known as thin-Ethernet cable and a 10-metre length will cost about $15. To that, you can add another $20 or so for the T-connectors and terminators.

So for $150 or less, you should be able to buy all the hardware you need to network two computers. Of course, this will depend on the networking cards you buy and the length of cable required.

## Avoiding conflicts

Generally speaking, a network card will fall into one of three categories: (1) software configurable plug and play (PnP), (2) software configurable and (3) hardware (jumper) configurable. The installation procedure for each varies somewhat but it's usually only a matter of following the instructions that come with the card.

A software configurable card is set up after it has been installed in the computer, using a small utility program supplied on a floppy disc. By contrast, a hardware configurable card uses various jumpers to select the IRQ (interrupt request) address, the I/O port and sometimes the memory address. The idea is to choose settings that don't conflict with other items of hardware before installing the card.

Windows 95 makes it easy to check which resources are free. You do this by first double-clicking the System icon in Control Panel. You then select the Device Manager tab, after which you click Computer and the Properties button (see Fig.1). This brings up the Computer Properties dialog box so that you can view current IRQ settings and address allocations (Fig.2).

Windows for Workgroups offers no such facility but that really doesn't present a problem. If you only have a bare-bones system, the factory default settings on the card will usually work. If some other item of hardware, such as a sound card, has been added, check its settings before configuring the network card.

Of course, you can always go for the well-proven trial and error approach. If everything still works after installing the network card, no changes are needed. If something stops working (eg, a sound card), simply change the IRQ setting and/or the I/O setting on the network card and try again.

This approach is not as difficult as it sounds because there will only be a few settings to choose from. For example, most network cards only let you select between IRQ3, 5, 9, 10, 11, 12 & 15. Be aware though that IRQ3 is reserved for serial port COM2 and will not be available unless this port is disabled. Similarly, IRQ11 is often claimed by a SCSI card (if one is installed), while other IRQs can be allocated to a sound card.

Obviously, the less hardware you have, the less chance there is for a conflict and the greater the chance that the default settings will work.

## Installing the network

So how do you get a network up and running? Well, the procedure is quite routine and you should have no

problems provided you install everything in a logical sequence. The procedure is as follows: (1) install the network cards and their software drivers; (2) connect the two computers together via a suitable cable; (3) nominate shared resources on one or both computers; and (4) connect to these resources via the network.

As an exercise, we recently decided to network a Pentium machine to an old 486 to simulate a typical home situation. And as would be typical of most home installations, two different operating systems were involved. The Pentium machine ran Windows 95, while the old 486 ran Windows for Workgroups version 3.11.

By the way, neither plain vanilla Windows 3.1 nor Windows 3.11 support networking. Instead, you must have Windows For Workgroups, so check the operating system first if you intend networking an old machine. Alternatively, Windows 95 comes with full networking capabilities but be wary about installing it on a machine with limited capabilities – particularly if it only has 4Mb of RAM.

On the hardware front, we already had a spare SMC8416BT network card, a suitable cable, and the necessary T-connectors and 50Ω terminators. All we needed was a second network card and this was purchased from a local supplier for $50. It was a fairly nondescript unit carrying an INET906BT type number and branded ExpertLan.

Because the SMC8416BT is a Plug and Play (PnP) device, we chose to install it in the Pentium machine. When we subsequently rebooted, Windows 95 correctly identified the card, automatically assigned resources to it and asked for the Win95 CD-ROM so that it could install the appropriate driver.

And that's all there was to it – our first network card was functioning correctly.

Of course, it's not quite that easy if you don't have a PnP card. In that case, Windows 95 won't automatically recognise the new card, so you have to install the driver yourself. You do that by double-clicking the Network icon in Control Panel, then clicking the Add button (see Fig.4) to bring up the Select Network Component Type dialog box. You then select Adapter and click Add to bring up a list of adapters.

After that, you just follow the on-

## Setting Up Windows For Workgroups

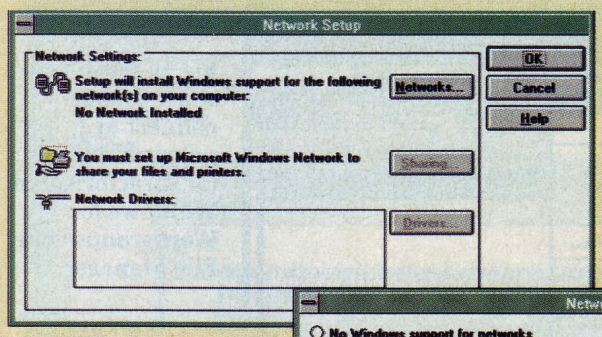



**Fig.4 (left): first, double-click the Network Setup icon in the Network group to bring up this dialog box, then click the Networks button.**

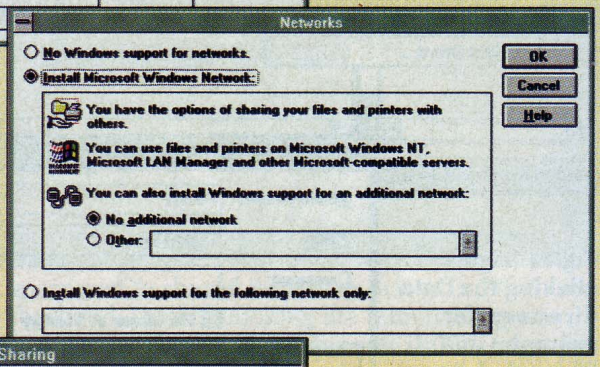

Networks
No Windows support for networks.
Install Microsoft Windows Network:
You have the options of sharing your files and printers with others.
You can use files and printers on Microsoft Windows NT, Microsoft LAN Manager and other Microsoft-compatible servers.
You can also install Windows support for an additional network:
No additional network
Other:
Install Windows support for the following network only:
OK
Cancel
Help

**Fig.5 (right): select Install Microsoft Windows Network and click OK. When you return to the dialog box of Fig.4, the Sharing and Drivers buttons will no longer be greyed out.**

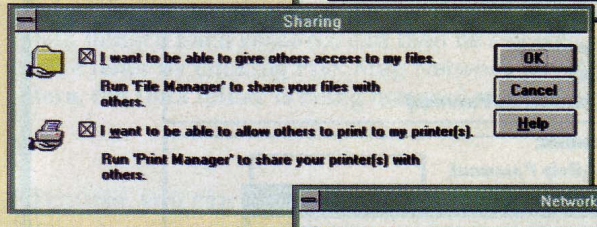

Sharing
I want to be able to give others access to my files.
Run 'File Manager' to share your files with others.
I want to be able to allow others to print to my printer(s).
Run 'Print Manager' to share your printer(s) with others.
OK
Cancel
Help

**Fig.6 (left): you select the resources that you want to be able to share in this dialog box.**

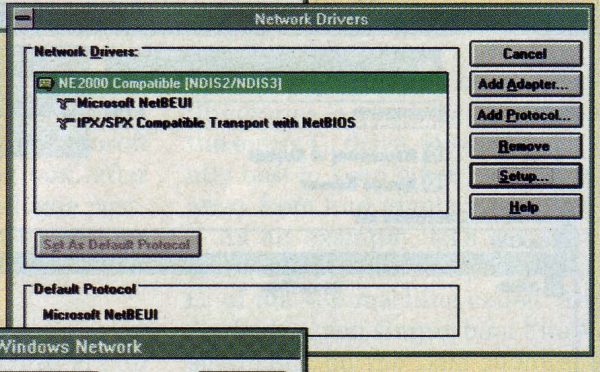



**Fig.7 (right): click Drivers, then Add Adapter to install a driver for your network card. You can check the resources allocated by clicking the Setup button.**

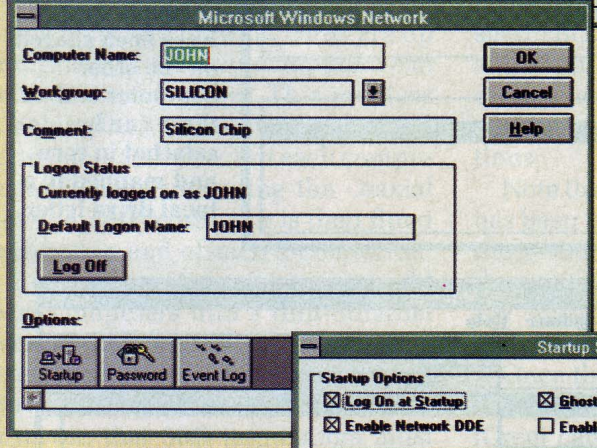



**Fig.8 (left): the Start-up and Password settings can be changed later on by double-clicking the Network icon in Control Panel.**

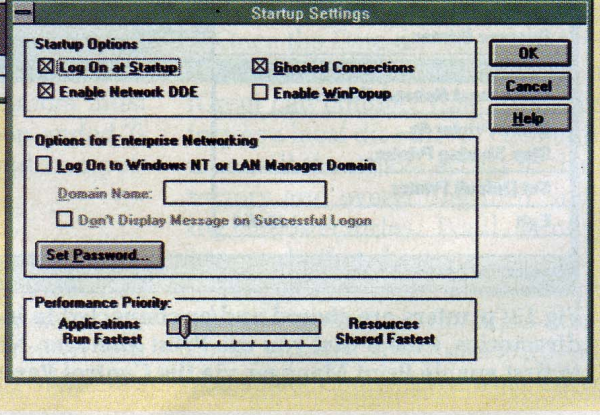



**Fig.9 (right): this dialog box shows the various options available at start-up. These are the default settings and are typical for a basic network.**

## Sharing & Connecting In Workgroups

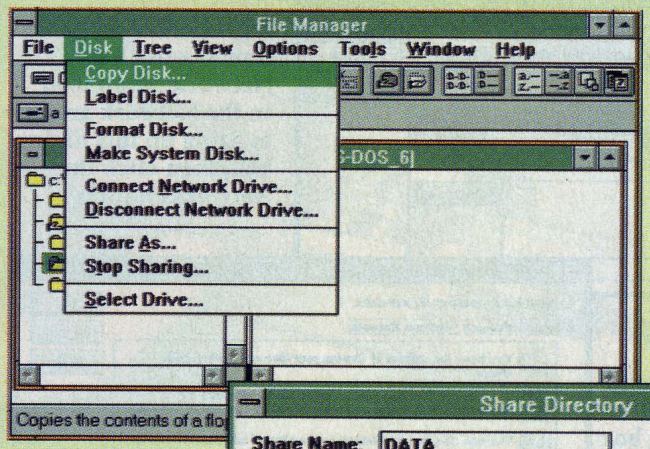



Fig.10 (left): you share and/or connect to network drives (or directories) in Windows for Workgroups using File Manager.

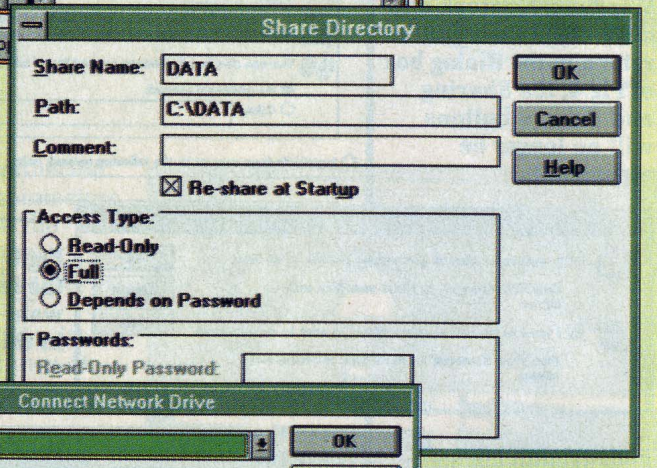



Fig.11 (right): clicking the Data directory (for example) and Share As brings up this dialog box. Note the options selected.

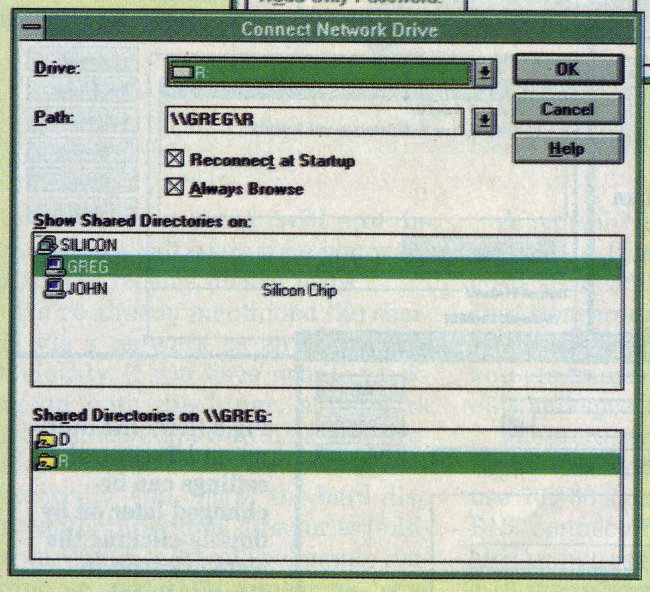



Fig.12: clicking Connect Network Drive at Fig.10 brings up this dialog box, which shows the computers on the network. Here, drives D: and R: have been shared on the other computer and these can be selected in turn and mapped to a local drive letter.

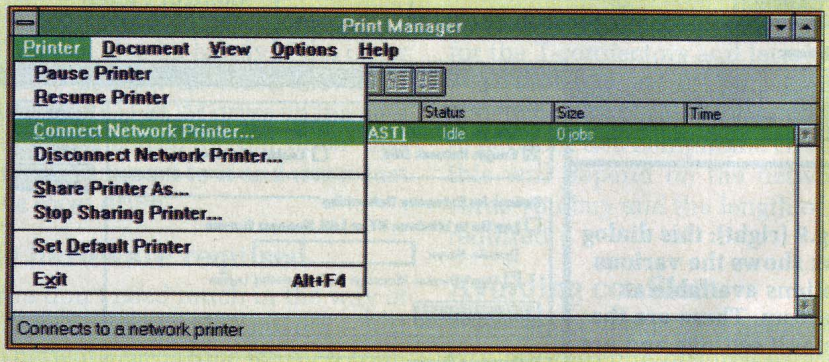



Fig.13: printers are shared and/or connected to in the same manner as directories, except that you use Print Manager. Note that you may have to first enable Print Manager via the Control Panel.

screen instructions to install the driver, either from the on-screen list or from the floppy disc supplied with the card. Note that when you set up a network adapter, Windows 95 automatically sets up the other network components (Client, Protocol and Service), so you normally don't have to worry about these.

Just out of curiosity, we decided to take a look at the resources assigned to the SMC network card. As shown in Fig.3, it grabbed IRQ 9 and I/O range 0240-025F. By the way, if a conflict is indicated here, you can use this dialog box to manually reassign the settings.

The 486 machine with Windows For Workgroups was also straightforward to set up. The INET906 is a software configurable network card and comes with IRQ 5 and I/O port 300H factory defaults. It also comes with a configuration/diagnostics utility on a floppy disc but no drivers were supplied.

In our case, we installed the card, then booted to DOS and ran the configuration utility. The default IRQ and port address settings were left as they were but we did select the thin Ethernet (BNC) connector instead of the default 10BASE-T (twisted-pair Ethernet) connector.

Actually, we're not too sure whether this step was really necessary as some cards "auto-detect" the connector that's being used. Unfortunately, the manual offers no guidance here, which was why we decided to play it safe. In any case, the auto-detect function doesn't always work with some cards.

Finally, we ran the diagnostic routines and these confirmed that the card was functioning correctly – at least up until it is actually connected to the network.

### Software setup

The next step was to boot the old machine and install network support and a suitable driver for the INET906BT card. This is done by first double clicking the Network Setup icon in the Network group. When the Network Setup dialog box appears (Fig.4), you click the Networks, Sharing and Drivers buttons in turn to: (a) install network support (Fig.5); (b) enable file and/or printer sharing (Fig.6); and (c) install the network driver (Fig.7).

Because no driver was supplied

with the INET906BT card, we chose the NE2000 Compatible driver from the list in the Add Network Adapter dialog box. As it turned out, this worked without any problems but note that you can also install your own driver if one is supplied – again, it's just a matter of following the instructions supplied with the network card.

During the driver installation procedure, a dialog box will appear asking you to confirm the IRQ setting. This invariably shows a default IRQ 3 setting and this should be altered if necessary, to agree with the card.

After that, it's simply a matter of clicking OK at the Network Setup dialog box, inserting various discs from the Windows For Workgroups set as requested, and following any other on-screen instructions. During the setup procedure, you will be asked to name the workgroup to which the computer is connected and you can use any name you like here (we chose the name "Silicon" for our two-computer workgroup).

## Mapping Drives In Windows 95

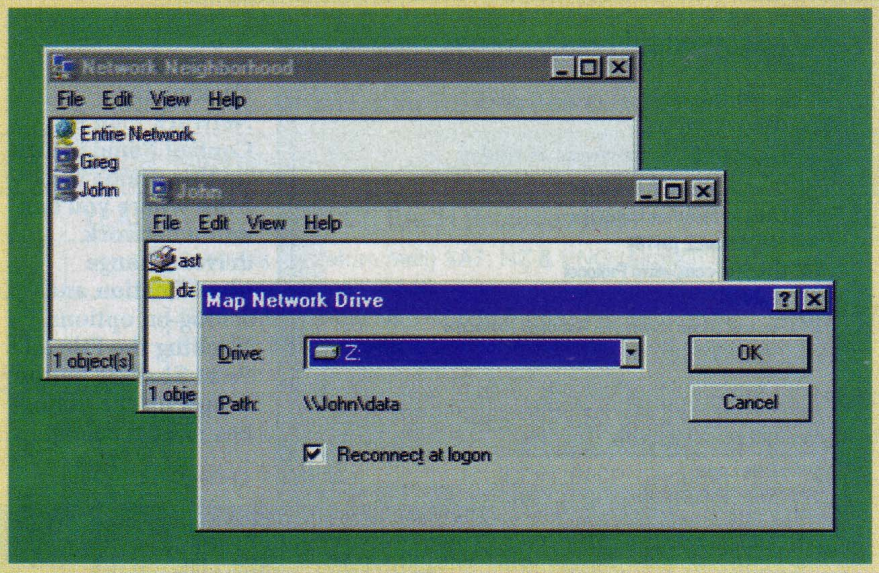



**Fig.14: the easiest way to connect to shared folders or drives in Windows 95 is via Network Neighborhood. Double-clicking the remote computer (John) then shows the shared resources on this computer (in this case the Data folder). Each resource can then be selected and mapped to a local drive letter by clicking File, Map Network Drive in the middle dialog box. Here, the Data folder is being mapped as local drive Z: .**

## Logon dialog box

When it's finished installing the new software, Windows instructs you to reboot so that the changes can take effect. This brings up a logon dialog box, into which you can enter a logon name and a password (if you need one). You are then prompted to create a password-list file (this lets you automatically logon to resources that require password access).

If you want to change the logon name, just type a new name over the default. The usual practice is to name the computer after the person who will be using it. In our case, we named the Pentium machine "Greg" and the 486 "John".

Don't use passwords unless you really feel it's necessary. Having to type a password every time you boot Windows or connect to a shared resource can be a real pain. Certainly, you don't need passwords in a home situation, unless you want to stop children from gaining access to certain files or resources.

If you want to be able to boot into Windows without logon hassles, leave the password box blank, click yes when prompted to create a password list and then click OK. From then on, the machine will boot into Windows without the logon box appearing.

Of course, you can always create or delete a logon password later on if you change your mind. You do that by double-clicking the Network icon in Control Panel to bring up the Microsoft Windows Network dialog box, after which you can change the logon password and set various start-up options – see Figs.8 & 9.

## Running the cable

Once the two network cards are up and running, the two computers can be connected together. This involves attaching the T-connectors to the BNC connectors at the back of each computer and then connecting the coaxial cable. A 50Ω terminator is then fitted to the open end of each T-connector.

By the way, it's quite easy to add extra computers into a thin-Ethernet network. All you do is connect the coaxial cable from one computer to the next in daisy-chain fashion. Note, however, that 50Ω terminators must always be fitted to the open-ended T-connectors on the two end computers.

## Sharing resources

At this stage, the network is all wired up but before you can connect to any resources, those resources must first be shared. This is done in Windows For Workgroups using File Manager and Print Manager.

Naturally, you can share as many directories as you want, or even share the entire C: drive. However, it's usually best to keep other network users away from important system files.

As an example, let's say that we want to share a subdirectory on drive C: of the 486 machine called "Data". To do this, you simply boot File Manager, click on the Data subdirectory, and then click Disk, Share As. The dialog box shown in Fig.11 appears and you can select the various options.

Note that the Reshare at Startup box has been checked because we wanted the resource to be shared each time the computer is booted. We also set the Access Type to Full so that we could alter files in shared directory.

Once the Data directory on the 486 has been shared, the Pentium user (Greg) can connect (map) that directory as a local disc drive. The Pentium user will then have access to that directory and everything in it, including subdirectories. We'll show you how to do that shortly.

The procedure for connecting to a shared resource on the other computer is equally straightforward. First, you select Connect Network Drive in

# Sharing Resouces In Windows 95

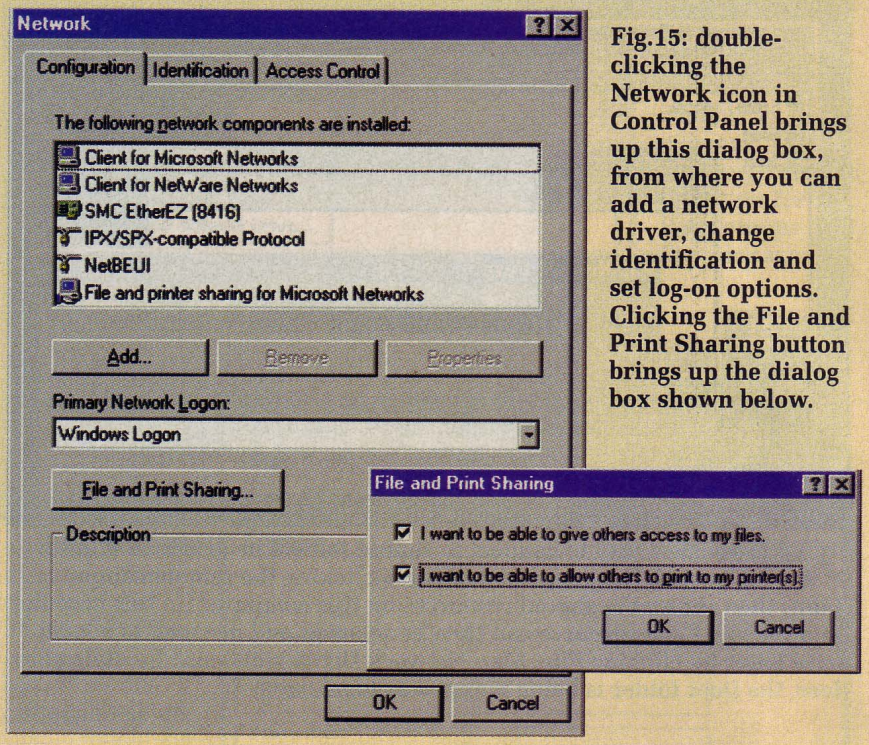



**Fig.15: double-clicking the Network icon in Control Panel brings up this dialog box, from where you can add a network driver, change identification and set log-on options. Clicking the File and Print Sharing button brings up the dialog box shown below.**

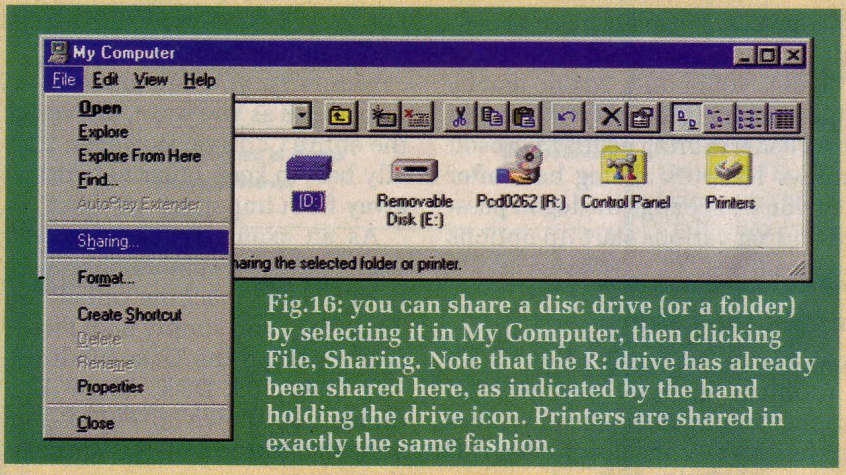



**Fig.16: you can share a disc drive (or a folder) by selecting it in My Computer, then clicking File, Sharing. Note that the R: drive has already been shared here, as indicated by the hand holding the drive icon. Printers are shared in exactly the same fashion.**

File Manager to bring up the dialog box shown in Fig.12. This shows all the computers on the network, in this case Greg (Pentium) and John (486).

Next, you select the remote computer (Greg) to view its shared resources. As can be seen, drives D: and R: (the CD-ROM drive) on this computer have been and we can select these in turn and map them to local drive letters. We mapped D: to local drive X: and R: to local drive R: on the 486 machine.

A similar procedure is used to share and/or connect to network printers, except that you use Print Manager (Fig.13). If Print Manager hasn't been enabled, you will have to enable it via the Control Panel.

## Windows 95 networking

As one might expect, networking is even easier with Windows 95. When you install a network card, the Network Neighbourhood icon automatically appears on the desktop. Double clicking this brings up the back dialog box shown in Fig.14 and, if everything is working correctly, you should see all the computers on the network.

Double clicking the remote computer (John) shows the shared resources on this machine. In this case, the shared resources are an AST laser printer and the Data directory referred to earlier. The Data directory can now be mapped as a local drive on the Pentium machine by selecting it and clicking File, Map Network Drive, then choosing the drive letter and clicking OK. We chose to map \\John\Data as drive Z (note: the path on a remote computer always begins with a double backslash).

Alternatively, you can connect (and disconnect) network drives via the icons on the toolbar of Explorer.

There are several ways to share folders (or disc drives). One way is via My Computer – you select the folder or drive you want to share, then click the File menu and click Sharing (Fig.16) to bring up the options dialog box. Alternatively, you can right click the resource in Explorer, select Properties from the menu, and click the Sharing tab from there. A printer can be shared in exactly the same manner.

If you want to connect to a remote network printer, you can use the Add Printer Wizard via My Computer. The procedure is the same as when connecting to a local printer except that you choose Network Printer when the wizard prompts you during the installation procedure. Alternatively, you can install a printer by double clicking on its icon in Network Neighbourhood.

It might all sound a little involved but it's really much more complicated in the telling than in the doing. In reality, you can share, connect and disconnect resources on a network in a jiffy, using just a few mouse clicks. And that's true whether you're using Windows 95 or Windows For Workgroups.

Once you have your basic network up and running, you can experiment with some of the communications features that networking offers, such as electronic messaging (Mail and Chat) and remote faxing. You will find all the advice you need in the Microsoft Windows manuals and in the help menus. The manuals also contain a wealth of information on networking in general so be sure to refer to them.

Finally, it's best to disable file and printer sharing before removing a machine from a network. If this is not done, the machine can take a long time to boot because it spends time searching for shared resources on a non-existent network. SC

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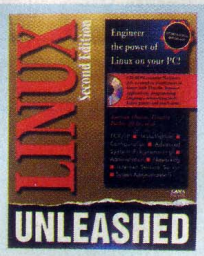


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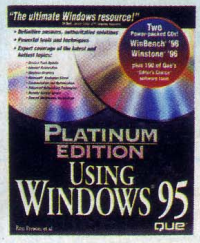


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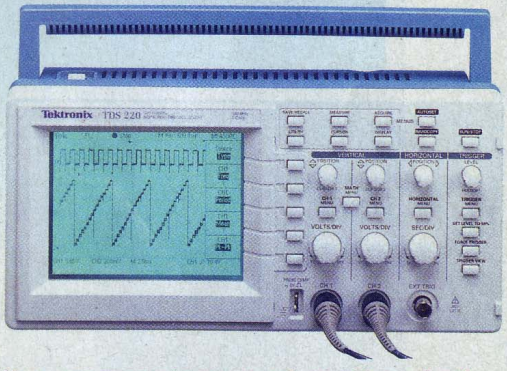


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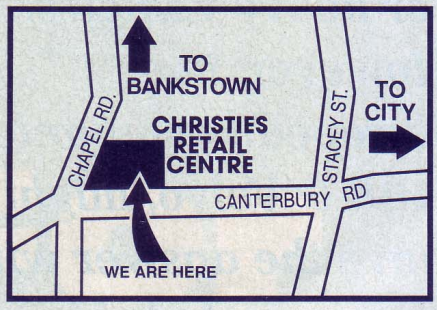


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# Not Just Low Pollution: No Pollution!

***Not long after the turn of the century, many vehicles will be required to emit not just low emissions but zero emissions. Battery power seems the way to go but currently the technology simply doesn't exist to make it happen, especially for heavy vehicles. However, two European companies, ABB & Volvo, might have the answer with their new hybrid drive system.***

# Hybrid Heavy

# Power For Vehicles

THE MAJORITY of man-made emissions responsible for polluting our cities come from cars, trucks and other road vehicles. These offer greater flexibility in the urban transportation sector than the other major land-based transport system, the railways, most of which are electrified today in cities and are therefore less polluting.

As a result, the emphasis around the world is to make road vehicles less polluting. Significant advances have been made in recent times but in many areas, not enough: new legislation in California, for example, will require 10% of all cars entering the market from 2003 to have zero emissions.

Most large vehicles on the road today run on diesel fuel. Recently clean-air legislators have started calling for heavy vehicles to be more environmentally compatible.

However, that is not simply a matter of lowering air pollution levels through the reduced emission of nitrogen oxides, hydrocarbons and suspended matter. Other factors such as the choice of materials, recycling potential and noise emissions have to be considered.

Unless some breakthrough is made in the next few years, zero emissions (at least as far as the vehicle itself is concerned) translates to battery powered vehicles. While battery power might become practical for cars and small vehicles, at the moment that is not the case, nor is it even on the horizon for larger vehicles carrying freight or passengers – trucks and buses, for example.

In the past, a large-scale shift to electric drives has failed mainly due to suitable rechargeable batteries being unavailable. For electric vehicles to travel acceptable distances without having to be charged too often, their batteries would have to be so large that they would seriously reduce the payload space.

The best solution, at least in the foreseeable future, is a hybrid vehicle, one which can operate from battery power in areas where zero emissions are required (eg in central cities) but switch to conventional or non-conventional motorised propulsion (albeit of low pollution) outside those areas.

Conventional internal combustion engines (diesel or petrol) are not really a proposition because even the best designs cannot, at least currently, achieve low enough pollution levels. One proposal by ABB and Volvo is for a high performance hybrid drive consisting of a gas turbine, a high speed generator and a battery. This new drive is designed to meet the stricter requirements of future clean air legislation.

ABB & Volvo have produced two 15-tonne concept vehicles using such drives. The Environmental Concept Truck and Bus (ECT and ECB) were both designed especially for use in urban areas.

## Development goals

To be commercially acceptable, hybrid vehicles have to perform as well as any modern, conventional road vehicle. Therefore a hybrid bus must be capable of about the same performance as a 'normal' city bus.

The concept vehicles were designed for a speed of 100km/h on the level and 80km/h on a 2% gradient (1 in 50). This meant that the drive needed a continuous output of 100kW and a maximum output of 150kW. The same maximum output, although only for a short time, is also required when the vehicle is run off the battery alone.

In a hybrid drive vehicle, the gas turbine can be shut down and the vehicle run from the battery alone; ie, with zero emissions. The battery-only range specified for the hybrid truck was 25km, with a minimum of 5km

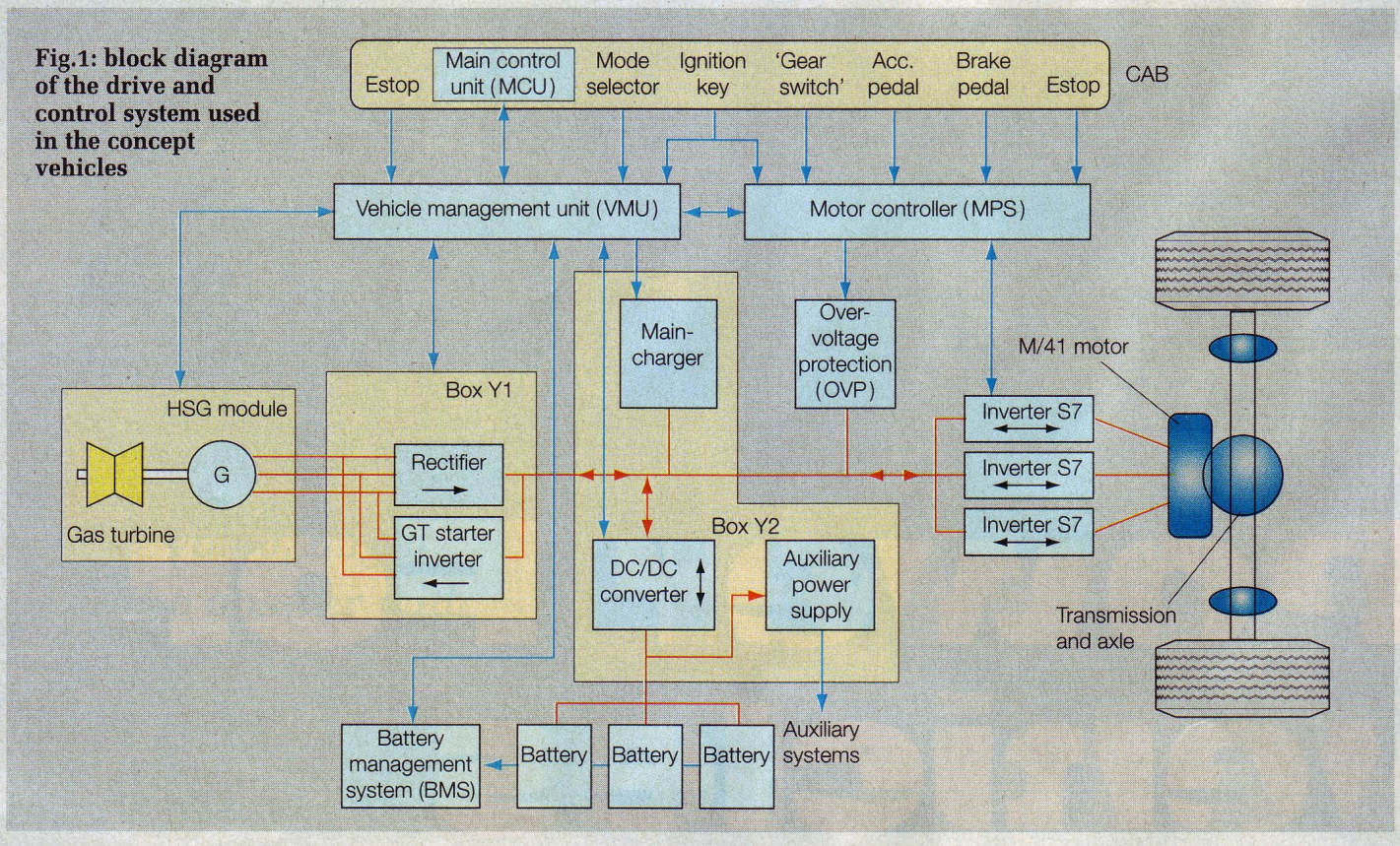



**Fig.1: block diagram of the drive and control system used in the concept vehicles**

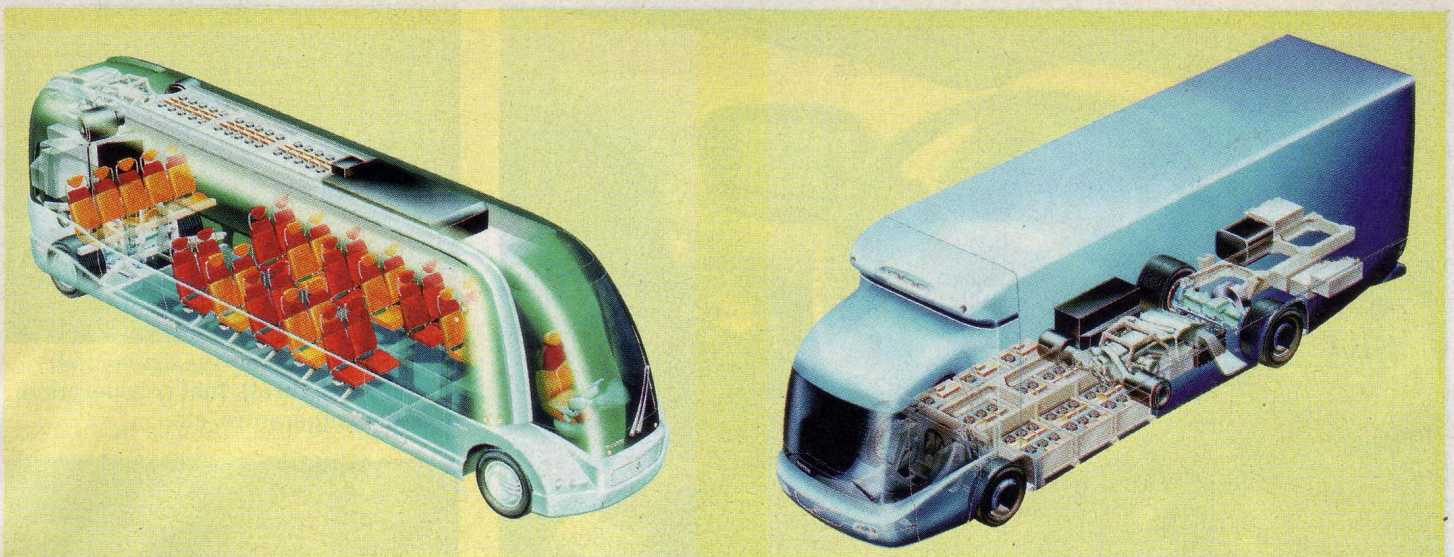


**Fig.2: low-emission concept bus and truck, each with a hybrid drive developed especially for urban service. The hybrid drive used in each case is an in-line unit consisting of three batteries, a gas turbine and high-speed generator mounted on the same shaft, and the electric rear-axle transmission. Hybrid drives reduce pollutant emissions and allow vehicles to be run on just batteries, for example in designated zero-emission zones.**

for the hybrid bus. Such a bus could start its journey in the centre of a city on battery power alone, with the gas turbine only coming on line outside the central business district.

## Parallel or series drive?

Hybrid drives can have either a parallel or series (in-line) configuration. With a parallel unit, either (or both) the electric motor and combustion engine can power the vehicle, the driver (or a computer) switching between each as required. In an in-line configuration the vehicle is always powered by the electric motor, the combustion motor either supplying the motor current or keeping the battery charged, or both, or neither (where battery power alone is used).

The hybrid drives installed in the concept vehicles employ an in-line arrangement and were developed jointly by *Volvo Aero Turbines* and ABB Hybrid Systems in Sweden.

The hybrid drive consists of a gas turbine and high-speed generator. Batteries form the second energy source. The drive was developed and designed on the basis of experience with the Volvo's 1992 ECC (Environmental Concept Car) with gas turbine drive.

The power plant's gas turbine consists of the turbine itself, a compressor, a combustion chamber and a heat exchanger. Besides recovering heat from the exhaust gases, the heat exchanger also acts as a noise suppressor.

## Gas turbine

A gas turbine engine burns fuel more completely than an internal combustion engine, resulting in lower emissions. In principle, a gas turbine can be run on virtually any type of liquid or gaseous fuel.

Ethanol (ethyl alcohol) was chosen for the concept vehicles. Ethanol is a biofuel, obtainable from vegetable matter and is a natural, renewable and abundantly available resource. Unlike fossil fuels, it is environmentally neutral in terms of its $CO_2$ emissions and therefore does not contribute to global warming. In addition, $NO_x$ emissions are one tenth of those of modern diesel engines. Suspended particle emissions are also marginal.

The vehicle management computer determines the actual power requirement which, since it depends on the

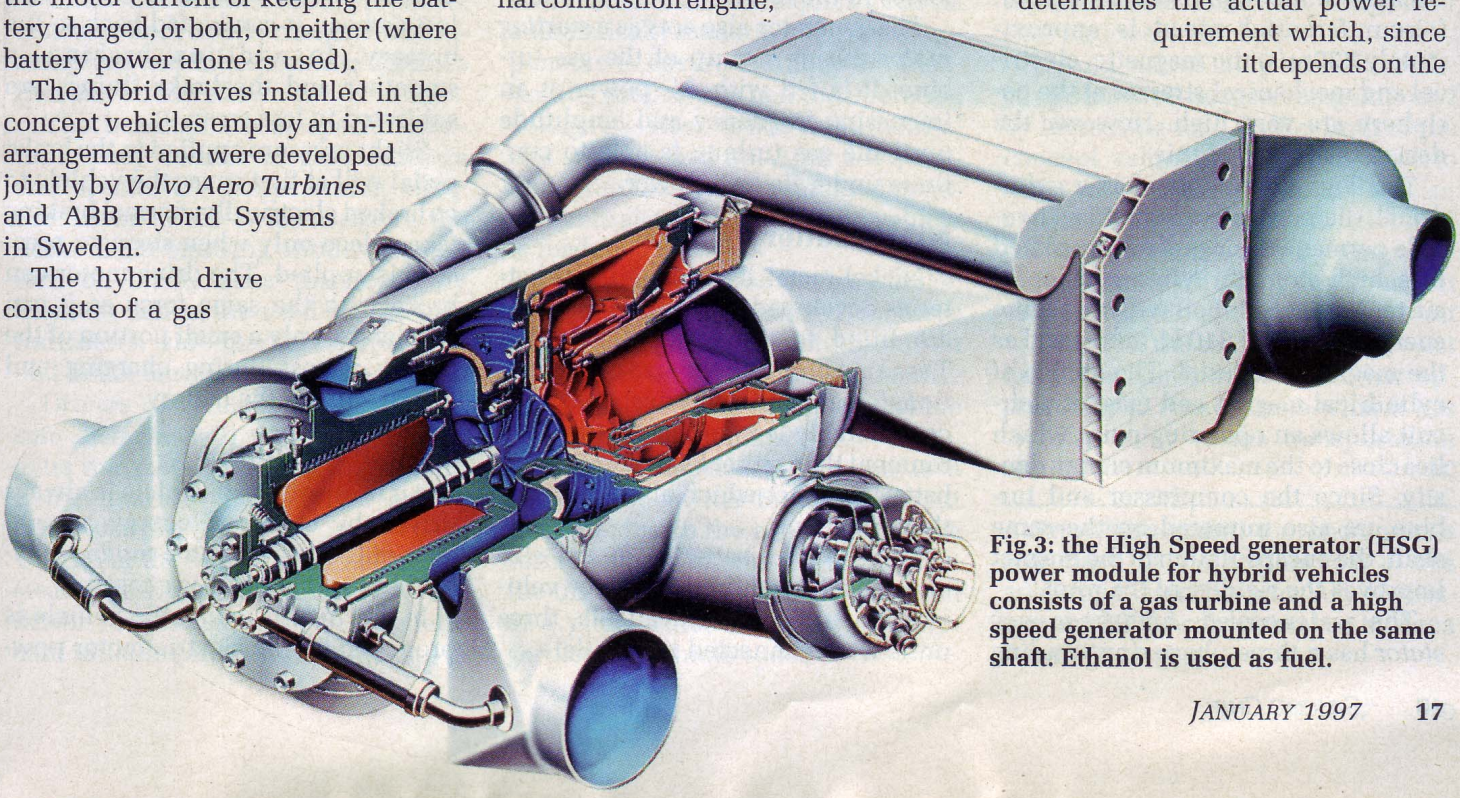
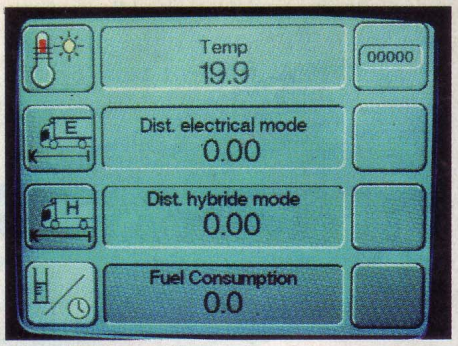
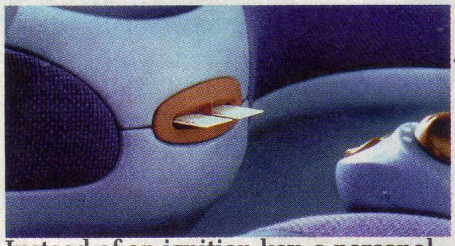


**Fig.3: the High Speed generator (HSG) power module for hybrid vehicles consists of a gas turbine and a high speed generator mounted on the same shaft. Ethanol is used as fuel.**

**The dashboard consists of a main display and two 'satellite' units mounted either side of the steering column.**




**The displays shows the drive mode (battery or hybrid), fuel consumption, outside temperature, etc.**



**Instead of an ignition key, a personal magnetic card is inserted to start the hybrid truck.**

traffic situation and the driving style, can vary greatly, particularly in a city.

The rotational speed of the turbine can vary between 50,000 and 70,000 rpm, corresponding to a generator output of 30-110kW.

## High-speed generator

As the turbine and generator are on the same shaft, the output of the generator can be easily regulated by varying the rotational speed of the turbine as the two are directly proportional. At 70,000 rpm, the line-to-line voltage is 450V.

Excitation is by a permanent magnet and with an air-gap wound stator. Because of the high rotational speed, (circumferential speed is approximately 230m/s) the magnetic, electrical and mechanical stresses at the periphery are very high. However the design takes care of this.

The *high-speed rotor* has a cylindrical, diametrically magnetised two-pole permanent magnet encapsulated in a high-strength cylinder made of austenite steel. NdFeB with a specific energy density of 310 kJ/m$^3$ is used as the magnetic material. The choice of cylindrical magnet and magnetic circuit allows an operating point which lies close to the maximum energy density. Since the compressor and turbine are also mounted on the same shaft, the encapsulation of the magnet improves the rigidity of the rotor.

The water-cooled *high-frequency stator* has a three-phase ring winding consisting of litz-wire stranded conductors with 3,780 insulated filaments. Punched magnetic sheet steel laminations, 0.2mm thick, make up the stator core. This is heat-treated in a special way to ensure very low hysteresis losses. The wound stator is encased in epoxy resin with boron nitride added to increase its thermal conductivity and strength.

Low losses in the rotor and the low core losses in the stator result in the generator having an efficiency of about 96 percent. Although the high frequency of 1,170Hz causes additional losses in the stator, these can easily be dissipated. A filter limits the harmonic losses in the rotor.

The generator also acts as a *starting motor* during run-up of the gas turbine. It is fed with AC power at an increasing frequency and amplitude until the gas turbine is able to continue under its own power.

## NiMH battery

Nickel-metal hydride (NiMH) batteries developed by Varta Batterie AG are fitted to the concept vehicles. These are only half the size of conventional lead-acid batteries and have considerably less impact on the environment than either lead-acid or NiCd batteries, a fact which also applies to their recycling.

Since NiMH batteries of the size and capacity required for heavy vehicles are still not yet available, three units were connected in parallel.

During hybrid operation, the batteries are charged at a relatively fast rate – from 20% to 80% in just 20 minutes. The batteries can also be charged from the mains which means that a bus could start its day fully charged using low cost (off peak) electricity.

## Transmission

Because the transmission is electric and the electric motor acts directly on the rear axle, a gearbox is not necessary. During braking, the electric motor functions as a generator. Instead of the braking energy being lost as heat, it can be fed back to the battery. In addition braking is smoother and the brake linings are subjected to less wear.

Slight pressure applied to the brake pedal will at first cause the vehicle to be braked electrically; normal braking takes place only when stronger pressure is applied. The drive motor can brake with the same force as it can accelerate; only a small portion of the energy is lost during charging and discharging of the battery.

## Two drive modes

An in-line hybrid vehicle is always driven by electrical energy, whichever of the two possible modes – hybrid or just battery – is chosen.

In the *hybrid mode*, the vehicle is propelled by the electric motor pow-

ered primarily by the high speed generator. When only a small amount of power is required there will be a surplus of energy, which will be stored in the batteries. When the power level required is higher than can be supplied by the HSG (approx. 110kW), the batteries provide additional energy. The combined maximum output of the HSG module and batteries is 142kW.

The driver can choose between automatic (ie, with the turbine switched on and off as a function of the battery charge status) and continuous turbine operation. In the latter case, if the batteries are fully charged the turbine runs at no load.

## The vehicle body

Electric transmission makes it possible for the driver's cab to be positioned just 60cm above road level, allowing eye contact between the driver and other road users as well as pedestrians. The transmission components are mounted in the roof of the bus. This enables its length to be reduced by 1.5m compared with conventional diesel-powered buses with the same number of seats.

Instrumentation is simplified compared to a normal heavy vehicle. It consists of a main unit in the middle of the dashboard and two 'satellite' units, one on each side of the steering column and fixed permanently to it. Since these two units move with each new setting of the steering wheel, they remain at the correct distance from the driver.

Other instruments show the power consumption, battery charge, fuel consumption and the remaining distance that can be travelled

The headlights bear special mention. They consist of gas discharge and special UV lamps which allow the driver to see twice as far in the dark. Light-emitting diodes, which turn on much faster than ordinary filament lamps, are used for the turn indicators, side-marker lamps, rear and brake lamps.

Drivers of vehicles following at a safe distance will therefore gain an extra five metres in which to respond if the hybrid vehicle driver has to brake sharply.

Driving the vehicle is unusual: instead of turning an ignition key, the driver inserts his personal magnetic card into the card reader. A symbol (a red truck) lights up on the dashboard to tell the driver that the starting procedure has begun.

Once the batteries have been switched into circuit, a quick check is automatically made of the system components to ensure that they are functioning properly. When the operating voltage has risen to 600V, the auxiliaries are switched on. After a few seconds, the red 'truck' symbol changes colour to show that the hybrid vehicle is ready.

The driver releases the handbrake, turns the selector switch to D for drive and presses the accelerator, upon which the bus starts to move smoothly and quietly. At this point, the turbine has still not started up.

Next to the selector switch is a changeover switch for the different drive modes. In the hybrid mode, the turbine starts automatically. All that the driver hears is a humming sound at a pitch which stays the same regardless of vehicle speed.

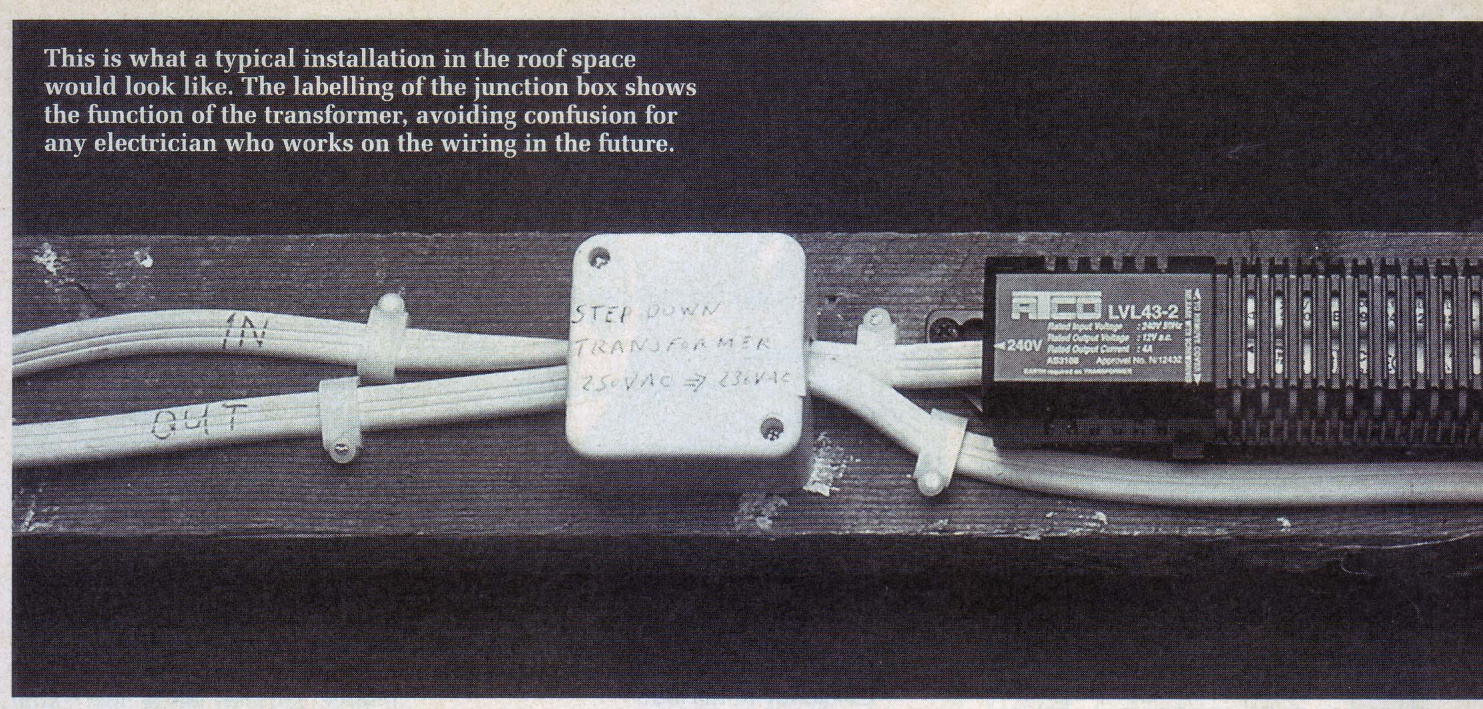
Since only very few operations, involving just a small number of controls are necessary, the driver can concentrate on the traffic. This also gives the hybrid vehicle a safety edge over conventional vehicles.

Hybrid drives help to reduce the environmental burden being imposed by increasing road traffic. Both of the concept vehicles have been used to test a whole series of innovations, including active suspension, all-wheel power steering and new lighting techniques, some of which are found at present only in sports cars or in test vehicles. At the same time the project has given the industry a further opportunity to demonstrate what it has to offer today to the transportation sector. **SC**

## Concept Truck & Bus Specifications

| | Truck | Bus |
|---|---|---|
| ***HSG module*** | | |
| Output | 110kW | 110kW |
| Efficiency at full load | 32% | 32% |
| Emissions | | |
| $NO_x$ | 0.5g/kWh | 0.5g/kWh |
| Suspended particles | 0.05g/kWh | 0.05g/kWh |
| ***NiMH batteries*** | | |
| Nom. energy storage capability | 72kWh | 45kWh |
| Rated voltage | 400V | 250V |
| Rated capacity | 3 x 60Ah | 3 x 60Ah |
| ***Electric rear-axle drive*** | | |
| Continuous rating 94kW | 94kW | |
| Maximum rating | 142kW | 142kW |
| Maximum torque | 2850Nm | 2850Nm |
| ***Vehicle*** | | |
| Efficiency at full load | 85% | 85% |
| Total efficiency at full load | 27% | 27% |
| Top speed on 1:50 gradient | 80km/h | 80km/h |
| Range in zero-emissions mode 25km | >5km | |
| ***Weight (approx values)*** | | |
| HSG module (turbine + generator) | 400kg | 400kg |
| Electric motor | 100kg | 100kg |
| Power electronics and servo-drives | 500kg | 500kg |
| Batteries | 1800kg | 1100kg |
| Cable | 100kg | 100kg |
| Cooling plant | 200kg | 200kg |
| Total | 3100kg | 2400kg |

**Acknowledgement:** the photographs and much of the original text in this article appeared the June/July 1996 issue of ABB Review, published by Asea Brown Boveri Ltd.




This is what a typical installation in the roof space would look like. The labelling of the junction box shows the function of the transformer, avoiding confusion for any electrician who works on the wiring in the future.

# Stop blowing incandescent lights

**Are you constantly blowing incandescent lamps? The chances are that your mains voltage is higher than normal. If so, this article presents an effective solution, using a cheap and readily available 50VA transformer intended for low voltage halogen lights.**

By LEO SIMPSON

Everyone knows the frustration when an incandescent lamp blows. It's dark. You can't see. You try flipping the switch up and down several times. Yep, it don't work. Have we got any spare bulbs? Hmm ... now where did I put them?

Come to think of it, where's that @$#%$ candle!

For many people, this scenario happens too often to be funny. Replacing bulbs frequently is not only a frustration, it becomes quite expensive, especially if they are special shapes such as reflector, candle, fancy round, globe or any of the Edison screw types.

Modern homes with cathedral ceilings and the like also pose a real danger in simply getting up there to change the things!

If you have this problem then it is probably because your mains voltage supply is above 250VAC.

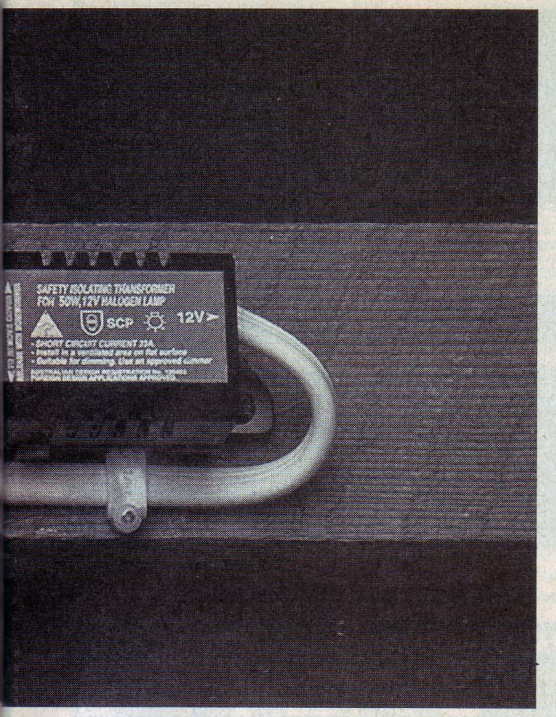
Why does it happen? The nominal mains supply in Australia is 240V, ±6%. By and large, the supply authorities do a pretty good job of keeping to this figure. But if you're unlucky enough to live at the start of a long cable run (and the supply voltage at the far end must be kept high enough to be usable) the chances are the voltage at your place is on the high side, typically well above 250VAC.

A 5% increase in mains voltage above the nominal 240VAC (ie, to 252VAC) will typically result in a reduction in incandescent lamp life of 30% or more. With 12V halogen lamps, it is even worse; a 5% increase in voltage above 12V results in half the normal lamp life!

It is possible to buy incandescent lamps rated for operation at 255VAC (eg, Philips High Voltage GLS) but they are only supplied in the standard shape and they are not widely available. Not only that, they are more expensive than "garden variety" lamps from your local supermarket.

The only way to cure this problem of short lamp life is to reduce the mains voltage to around 240VAC. Now you can bet that your local electricity supply authority is not going to be too helpful in this regard so it is up to you to fix it. But how?

One way is to use a standard light dimmer. When set to maximum brightness, a dimmer will reduce the mains




voltage by about 2VAC. To reduce 250VAC to around 240VAC, you need to set the dimmer knob at about 25° less than the full brightness setting. And then you need to remember to leave it at that setting otherwise the lamp will get almost the full voltage.

Incidentally, you may have noticed that lamps fitted with dimmers last significantly longer than lamps which are simply switched. This is because turning up a dimmer from zero to full brightness, even quite quickly, effectively "soft starts" the lamp.

Clearly, though, having a dimmer on every lamp in your home is not practical. There is a better way and it involves using a cheap and readily available 50VA 12V halogen lamp transformer.

As the description suggests, these transformers are designed simply to drive a 12V 50W halogen lamp but we are about to describe their use as a step-down auto-transformer and in this mode they can drive up to 1000 watts of 240VAC incandescent lamps. How can this be? It is not a trick, nor is it a new idea.

In principle, the 12V secondary winding of the transformer is connected in series with the 240V primary, as shown in Fig.1. In effect, this produces a 252V winding with a tap at 240V. The total current drawn by the transformer will be sum of the primary current $I_P$ and the load current $I_L$.

Notice that the load current $I_L$ only

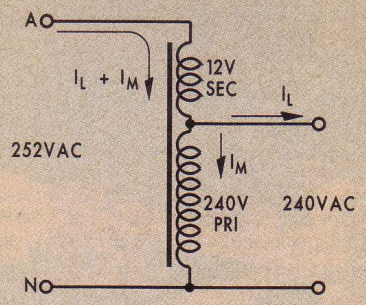



**Fig.1: the auto-transformer concept, showing how the heavy load current only flows in the low voltage winding. This means that a 50VA transformer can supply a 1kW load.**

flows through the 12V winding of the transformer. Since the 12V winding is rated at 50VA this means that it can carry 4.17A (50/12 = 4.17A). The primary winding, by contrast, carries just a fraction of this current, by transformer action. Typically, this amounts to a few hundred milliamps, comprising a magnetising current of about 100mA and the "transformed" secondary current, of about 200mA.

Hence, although the transformer is only rated to deliver 50VA (ie, 50 watts) when connected as a conventional step-down transformer, in this auto-transformer connection it can deliver 1000 watts (240V x 4.17A = 1kW).

By the way, the VA term used to describe transformer ratings is derived from "volt-amps". It is not quite the same thing as watts but in this application 1VA is equivalent to 1 watt.

Such a 50VA transformer would be able to supply the lighting for several rooms in a typical home or even as much as half the total lighting load in a small home.

The 50VA transformer in question is made by Atco Controls Pty Ltd and is listed as their type LVL43-2. It has short circuit protection and a built-in self-resetting thermal cutout. Atco Controls Pty Ltd is a major manufacturer of fluorescent light ballasts and this transformer evidently makes use of standard ballast laminations, bobbins and other hardware. In addition, as can be seen, the transformer is supplied with a complete plastic shroud.

The transformer is intended to be permanently wired into household wiring circuits and would normally be installed in the ceiling space of a home. That is how we envisage it will be used in this auto-transformer application as well.

## Connecting the windings

Fig.1 shows the concept of the auto-transformer connection while Fig.2 shows the actual connection circuit in a typical installation. Note the black dots on the two windings to indicate polarity. The 12V secondary winding must be connected the right way around for the transformer to provide a step-down function. If the primary winding is connected the wrong way around, it will provide a step-up function and that is definitely not what we want!

While Fig.2 shows dots to indicate winding polarities, no such polarity indications are provided on the specified transformer because normally they are not necessary. This means that the connection will be a matter of trial and error: connect it up, power it up and check the voltage with a multimeter.

## Electrician's job

What we are suggesting is that typical homes will need between one and four of these 50VA transformers to supply the full lighting circuit. Typically, two transformers will be required for an 8A lighting circuit; three transformers for a 10A circuit; four transformers for two 8A circuits and so on.

If you have a lot of fluorescent lights in your home, we suggest that they are

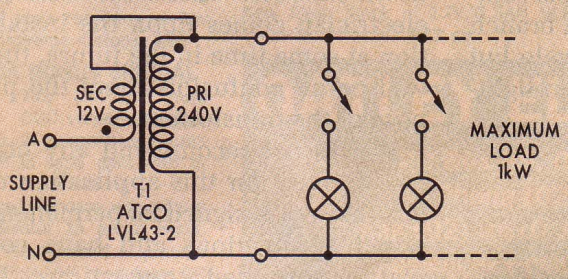
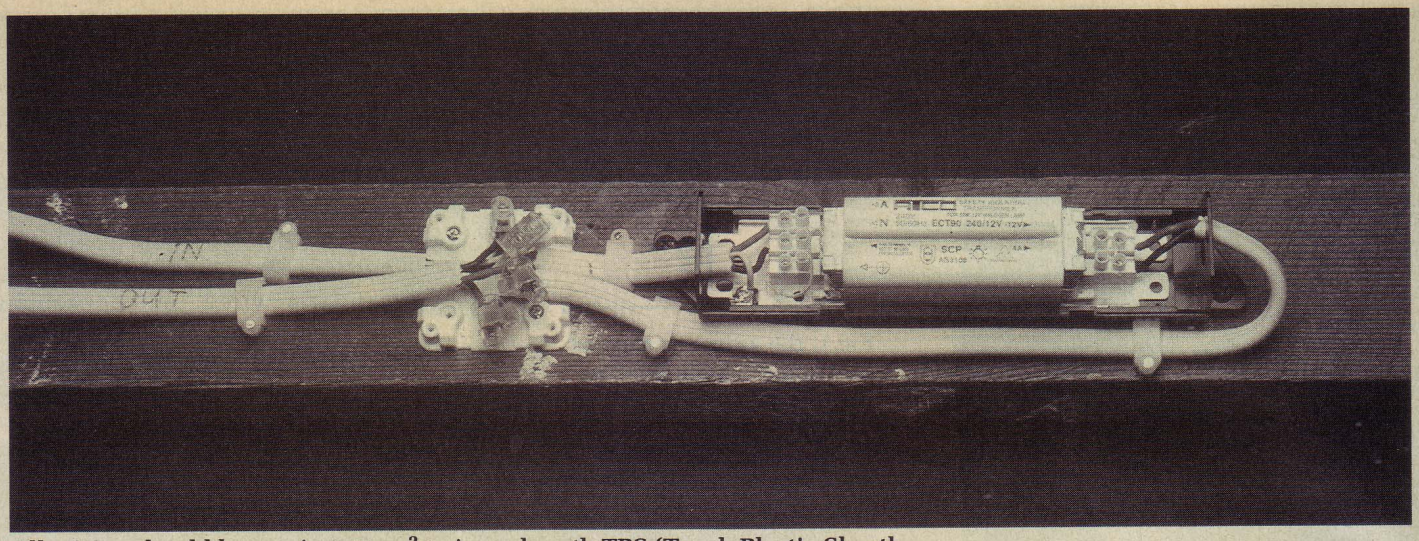



**Fig.2: a typical installation will use two step-down auto-transformers to supply an 8A domestic lighting circuit.**



**All wiring should be run in 1.5mm$^2$ twin and earth TPS (Tough Plastic Sheathed) cable and be properly anchored. Note that the work must be carried out by a licensed electrician.**

not run from the step-down transformer. For a start, the life of fluorescent lights is not seriously prejudiced if the mains voltage is high. Secondly, since domestic fluorescent light fittings do not have power factor correction capacitors, there is significant phase lag between the voltage and current in the ballast and this could lead to additional heating in the step-down transformer.

Incandescent lights with dimmers may be run from the reduced mains voltage without problems.

Since the transformers will be permanently wired into your home lighting circuits, they must be installed by a licensed electrician. Furthermore, the transformer will be continuously powered; not switched. As we see it, they could be installed on your switchboard, if there is room, or in the ceiling space.

Either way, the lighting circuits will need to be split, so that the transformer never supplies more than its rated current.

Note that you can purchase higher rated 12V halogen lamp transformers, in ratings of 75VA, 100VA, 160VA, 200VA and so on but it is not economic, compared to the low price of the 50VA type. We purchased our sample transformer at $18 from a branch of Cosmo Lighting in Brookvale but they are widely available from lighting suppliers everywhere.

## How to do it

While a licensed electrician must do the actual wiring installation, a number of electricians looked blank when we described the concept. Therefore we are featuring photos of a dummy installation. All wiring must be run in 1.5mm$^2$ twin and earth TPS (Tough Plastic Sheathed) cable, properly anchored etc.

The dummy installation shows the transformer primary and secondary connections are taken via the sheathed cables and all terminations are done inside a standard junction box. When the wiring is done, it is essential that the output voltage is checked with a multimeter to ensure that the transformer has been connected properly to step down.

For example, we had to check our own dummy installation. When checked, we had 250VAC in and 264VAC out. As we also had a 60W bulb wired in a socket across the output, it glowed rather brightly! We then disconnected the power, swapped the transformer secondary connections and checked the output again. This time it was 250VAC in, 236VAC out; all correct.

It is also a good idea to mark the input and output cables, IN and OUT, so that there is no confusion about the installation. Finally, it is a good idea to put a label on the junction box, indicating that it is providing a step-down function. That way, if another electrician comes upon the installation at some time in the future, there will be no confusion about the purpose of the transformer.

We do not recommend any other transformers for this application unless they are designed for permanently wired applications and have completely shrouded connections. The transformers must have free air flow around them, unimpeded by any ceiling insulation material, otherwise they will overheat and may be subject to nuisance tripping of their thermal circuit breakers.

## Running hot

Note that when fully loaded, the transformers do run quite hot. While it is difficult to put an actual figure on it, we would expect the metal laminations to run at about 50°C above ambient at full load. When you consider that above-ceiling temperatures can easily run above 50°C in summer, the winding temperatures of these transformers can be expected to run at around 120-130°C! They are designed for it.

As a mitigating factor, normal household lighting circuits seldom, if ever, run at full capacity and neither will the transformers in this application. Another mitigating factor is that the lights are normally used at night when it is cooler in the ceiling anyway!

We tested our sample transformer with a 1kW bar radiator and found that it stepped our 249VAC supply down to just under 236VAC. With smaller loads, there was a greater step-down. For example, with a 60 watt lamp load, the step down was just over 14V, from 249VAC to under 235VAC.

To recapitulate, if your mains supply is consistently above 250VAC, it is worth installing these 50VA transformers as described above.

By the way, even though they are permanently powered, the no-load power draw is quite low, of the order of several watts so the cost of operation is negligible. **SC**

### COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT
PCB and components kit plus information booklet and IBM software. Includes two stepper motors: **$44** Cable and power supply not included.

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Two 5mW at 660nm (very bright!) laser pointers. One a small flat plastic case, the other in a small metal cylindrical case fitted with a keychain. Greatly reduced prices: **$55** ea

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Small complete unit with cold cathode UV tube, works from two AA batteries (not supplied). Inverter can dimly light a 4W fluoro tube: **$5** ea or **5 for $19**

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Dual element Heinam LH1958 sensor plus fresnel lens: **$5** or 5 for **$20**

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Used cases from PIR movement detectors, with Fesnel lens and PCB. Ideal as a case to conceal a CCD camera: **$2.50** ea or 4 for **$8**

### PLASMA EFFECTS SPECIAL
Ref: EA Jan '94. PCB and all on-board components (flyback transformer included), and instructions: **$28** Amazing results if used with a non-functional but gassed laser tube, available for an additional **$14** if purchased with the plasma kit.

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Kit includes a blemished fibre optic coupled IR converter tube and our night vision HT power supply kit. The tube responds to IR and visible light, and can 'see' the output of an IR remote control: **$30**

### LED FLASHER KIT
3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50** ea, 10 for **$12**

### SIMPLE MUSIC KIT
3V, 3-pin IC plays a single tune. Two ICs that play different tunes, speaker and small PCB: **$3** ea, 10 for **$25**

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Small jewellers eyepiece: **$3**, 30mm loupe: **$8**, 75mm loupe: **$12**, 110mm loupe: **$15.** Set of one each of these magnifiers: **$30**

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Redesigned 5mW 660nm visible laser diode kit so the PCB fits into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **$85** (NEW LOW PRICING)

### STEPPER MOTOR PACK
Pack of seven mixed stepper motors. Save 50%! All new: **$36**

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IRFZ44 N-channel MOSFETs at a realistic price. 60V (max), 0.028 ohm on-resistance, 50A (max). TO220AB package: **$4** ea, 10 for **$30**

### MINIATURE FM TRANSMITTER
Very small ready-made FM transmitter in a small black metal case. Powered by a 1.5V watch battery (included), has an in-built electret microphone. Tuning range: 88 to 108MHz (adjustable). Range approx 50m: **$32**

### SOLID STATE PELTIER DEVICES
12V 4.4A, can be used to make a thermoelectric cooler - heater. Basic info included: **$25** 12V DC fan: **$8**

### IR REPEATER KIT
Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

### VISIBLE LASER DIODE MODULE
5mW/650nm laser diode module with adj. focus, ideal for making a complete disco laser with other components listed here: **$70**

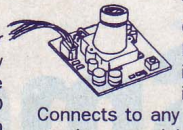
### GIANT ONE DAY SALE
In March we will be combining with a major electronic recycling company in a one day sale at a central Sydney location. Offered will be computers, electronic and mechanical components, batteries, motors, optics etc etc. **Keep watching our ads for more information.**

### ARGON-ION HEADS
Used Argon-Ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. Power supply circuit provided. Size: 35x16x16cm, weight 6.0kg. 1 year guarantee on head. Needs a 1kW transformer, available elsewhere for about $170. Argon head only: **$400**

### HIGH VOLTAGE AC SOURCE
Produces a high frequency, high voltage AC for ionising most gas-filled tubes up to 1.2m long. Can partially light a standard 36W fluoro tube. Includes PCB, small fluoro tube and components: **$18**

### AUTOMATIC LASER LIGHT SHOW KIT
Three motors, mirrors, PCB and component kit, has laser diode regulator. Can be cased and operated from a computer. Produces a huge range of patterns: **$70**

### CAMERA - TIME LAPSE VCR RECORDING SYSTEM
Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90**

### CCD CAMERA BONUS SPECIAL

Tiny (38x38x27mm) CCD camera, 0.1 lux, IR responsive (works in total dark with IR illumination). Connects to any standard video input or via a modulator to aerial input. SPECIAL *pack 1*: standard or pinhole camera with bonus VHF modulator OR regulated 10.4V plugpack. REDUCED PRICE **$140** SPECIAL *pack 2*: pack 1 PLUS video transmitter: **$155**

### LOW COST IR ILLUMINATOR KIT
Allows a CCD camera or a night viewer to see in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs. REDUCED PRICE: **$30**

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Standard large supply as used in large computer towers. 5V/22A, +12V/8.5A, –5V/0.5A, –12V/0.5A. Used but in excellent condition. Guaranteed: **$30**

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FM **STEREO** transmitter, tuning range: 88 - 108MHz, supply 6-12V, current 8mA (@ 9V), PCB size 25 x 65mm. Kit includes PCB and all on-board components, 9V battery connector, and 2 electret microphones: **$25** Plastic case to suit: **$4**

### WIRELESS IR EXTENDER
Converts the output of any IR remote control unit to a UHF transmission. Tx is self-contained (includes battery), attaches with Velcro strap under IR transmitter. Rx has 2 IR LEDs, and is placed near appliance being controlled. Kit includes two PCBs, all components, 2 plastic boxes, Velcro strap: **$35.** (9V battery for transmitter not supplied.) Suitable plugpack: **$10**. Components for 24V: **$1.50**

### GAS SENSORS
General purpose combustible gas and alcohol sensor, with data: **$18**

### MIDI KEYBOARD
Quality MIDI keyboard with 49 keys, 2-digit LED display, MIDI out jack. Size: 655 x 115 x 35mm. Computer software included: **$80** 9V DC plugpack: **$10**

### VIDEO SURVEILLANCE SYSTEM
A ready made CCD video and **AUDIO** security system. Includes a small, low light CCD camera in a waterproof case, a 5 inch monitor and a long connecting cable. Monitor has two camera inputs, for manual or auto switching between cameras. Camera has IR illumination and a microphone. Needs 12V/1.2A supply: **$299**

Computer case and supply (see below) available with this system for an extra **$10**. Monitor and connecting lead available separately for **$130**. **Note:** Our $130 CCD camera can also be used with the system.

### COMPUTER CASE AND SUPPLY
New, low profile metal computer case with a quality Australian made switch mode power supply: 240V AC to 12V/2A DC and 5V/5A DC. Includes IEC (I/P and O/P) connectors, fuse and switch. Off white, 50(h) x 360(w) x 380 (d) mm. Great for projects, CB power supply etc: **$20**

### 12V BATTERIES AND INTELLIGENT GEL CHARGERS
Intelligent 'plugpack', 240V-12V gel battery chargers, 13.8V/650mA, proper 'switching' design, with LED status indicator: **$8.80**

New fresh stock of 12V/6.5AH SLR batteries (Hitachi): **$33** ea

### DIGITAL RECORDING MODULES
Small voice recording modules as used in greeting cards. Powered by watch batteries (included). Also includes a suitable mini electret microphone. 6 second module: **$9**

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Brands include Sprague, Mallory, Seimens, Mepco, GE. Typical values: 5.4kμF-30V, 6kμF-50V, 40kμF-75V 9.6kμF-200V, 3.3kμF-200V: **$3–$8** ea

### 12V - 2.5W SOLAR PANEL KIT
US amorphous glass solar panels 305 x 228mm, Voc 18-20V, Isc 250mA: **$22** ea, 4 for **$70**
Efficient switching regulator kit suits 12-24V batteries & 0.1-16A panels: **$27**. Simple shunt regulator kit: **$5**

### MASTHEAD AMPLIFIER
MAR-6 IC-based high performance low-noise masthead amplifier covers VHF-FM-UHF. Includes two PCBs, all on-board components and a balun former: **$15** for basic kit. Suitable plugpack: **$6** Waterproof box for masthead amplifier: **$2.50**, plastic box for combiner: **$2.50**

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A complete central locking kit for any vehicle. Good quality, with Mabuchi motor actuators. Can be controlled from existing UHF remote controls. Kit includes 4 actuators, control box, wiring harness, screws-nuts, other mechanical parts: **$60.** Actuators are available separately: **$9** ea

### CODE HOPPING UHF CENTRAL LOCKING KIT with UHF REMOTE
Uses code hopping encoder and decoder ICs for ultimate security. Similar to the above system, but has built-in UHF receiver. Includes two matching 2-button UHF transmitters. One button locks, the other unlocks. Receiver has 3 relays: two for central locking and one that's activated in the lock position — for immobiliser etc. Kit also includes 4 actuators, control box, wiring harness etc: **$109**

### WOOFER STOPPER
Ref SC Feb '96. Kit includes PCB, all on-board components, transformer, electret microphone, one piezo speaker: **$39** Approved 12V DC 1A plugpack: **$14** *NOTE*: Works with most wildlife, including kangaroos.

Up to 3 additional piezo speakers with each kit: **$6** ea. Previous purchasers can take advantage of this offer.

### STANDARD PIEZO TWEETERS
Square, 85x85mm, 4-40kHz, 35V RMS: **$8.** 67x143mm, 3-30kHz, 35V RMS, wide dispersion: **$9**

### NEW NICAD BATTERY BARGAIN
6 PACK (7.2V) of 1.2V/800mAh AA NICAD cells, plus a thermal switch: **$4** per pack (of 6) or 5 packs for **$16**

Flat rectangular (48x17x6mm) 1.2V 400mAh NICADs with thermal switch: **$4** per pack or 5 packs for **$16**

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Unusual lens assemblies from industrial equipment: **3** for **$22**


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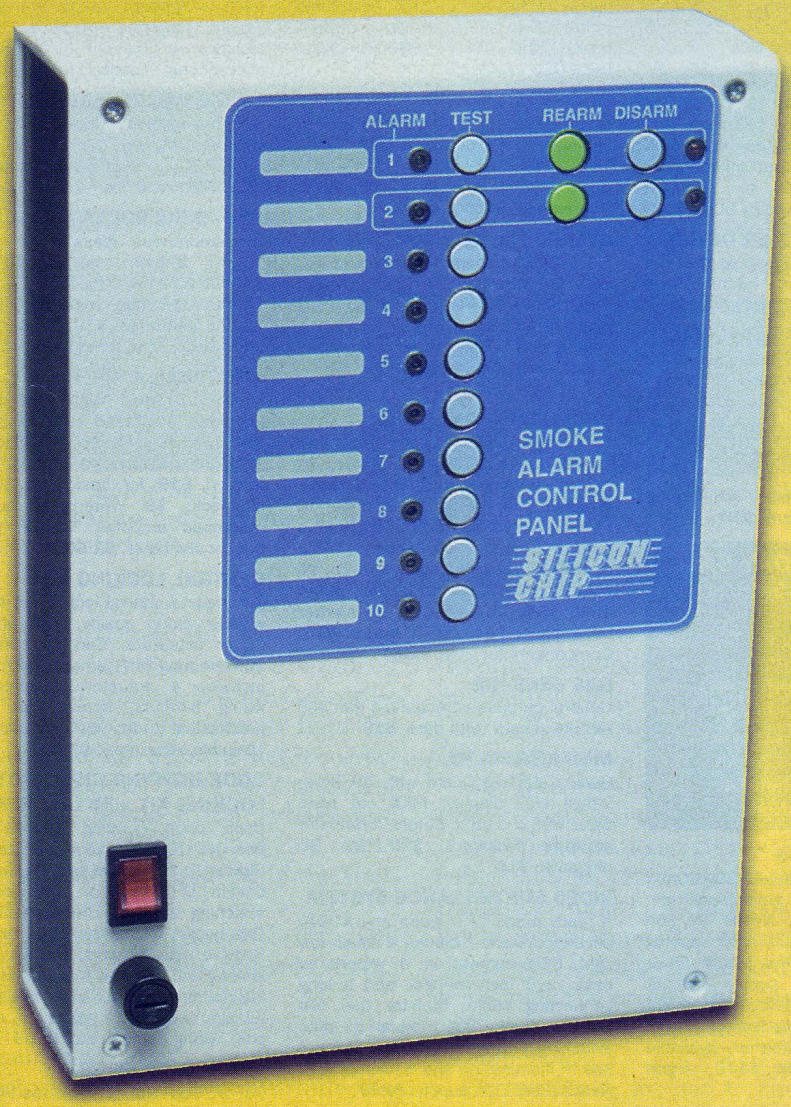
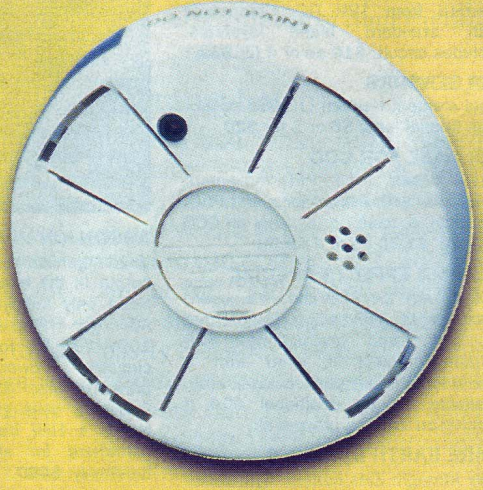


This Smoke Alarm Control Panel will power and monitor up to 10 smoke detectors. It provides a neat solution to the problems of using multiple smoke detectors throughout a house.

**BUILD THIS**

**These days, many homes have smoke detectors and new homes in most Australian states must have them. But what if you have a large house? Individual battery operated smoke detectors are not practical. This Smoke Alarm Monitor is an effective answer for a complicated problem.**

# Control Panel For Multiple Smoke Al

## Features

- Based on battery operated smoke detectors
- Monitors up to 10 smoke detectors
- Mains power operation (9V batteries not required)
- 12V battery backup
- Flashing LED power indicator in each smoke detector
- All alarms activated when one smoke sensor is triggered
- Extra alarm output
- Alarm silencing for two smoke detectors
- Alarm test on control panel
- Indication of triggered smoke detector
- Four-wire connection (telephone wire) between smoke detectors and control panel

DO YOU HAVE a smoke detector in your home? Only one? Then you're not really protected against fire. If you have a small house with only two bedrooms and all the internal doors are always kept open, then one smoke detector may be enough. But if you have three or four bedrooms and children or teenagers in the house, then one or two smoke detectors is definitely not enough.

Picture the scenario. A fire starts in a computer or music system in one of the bedrooms which has its door shut. You're asleep in your bedroom and your door is shut too. You've had a full day and you're a heavy sleeper as well. And you have one smoke detector in the hallway, say. What chance is there of you being woken up before the house is well alight? Not much.

Don't be lulled into a false sense of security. To effectively monitor for fire, you need a smoke detector in every bedroom which is used, particularly if it has any electrical equipment in it – electric blanket, radiator, clock radio, TV, computer or music system. Most of these appliances are permanently plugged in and fires can start in any of them.

You also need smoke detectors in your living areas and study or any area where there is electrical equipment. Count in your laundry, workshop or hobby room but leave out your kitchen and garage. You will probably find that you need between six and 10 smoke detectors, or even more if you have a large two or three-storey house.

Trouble is, even if you have that many smoke detectors, if they are battery operated and not linked together, you still have the problem of a fire starting in a closed room and you won't hear the alarm. And the idea of having 10 battery-operated smoke detectors is not practical – replacing batteries at regular intervals is not cheap or convenient.

One answer is to use mains-powered smoke detectors. Typically, up to 11 of these can be linked together and if one detects smoke, they all go off. This is a much more effective solution but it is quite expensive. Typically, mains-powered smoke detectors cost about $60 each; $60 x 10 detectors = $600!

In addition, they must be installed by an electrician so a typical installation with 10 detectors could easily cost $1500 or more. And you still have the regular cost of replacing the back-up batteries. Add up the cost of replacing the batteries in ten smoke detectors over a period of 10 years and the cost is hundreds of dollars.

Furthermore, what if you want to have a birthday party where the kids want to blow out the candles three times? Or a candlelit dinner? Or an open fire in the winter evenings? Or someone likes to have a cigarette after a meal? Having all smoke detectors linked together in those circumstances could be a trifle inconvenient.

### An effective solution

The SILICON CHIP Smoke Alarm Control Panel is designed to power and monitor up to 10 modified smoke detectors. We're talking about the cheap battery smoke detectors which you can buy everywhere for around $10. They are all linked together with 4-way telephone cable so there is no need to call in a licensed electrician – you can do the installation yourself. The Control Panel is mains powered but also has battery backup to cope with electricity blackouts.

As a bonus, two of the 10 smoke detectors can be disabled for periods up to four hours, after which they will

## Specifications

- Supply to smoke detectors ..... 9.0V - 9.75V
- Current consumption ..... 26mA @ 9.4V with alarms off
- Total current with 10 alarms sounding .... 1A
- Standby power ..... 1.2Ah 12V SLA battery
- Battery trickle charge ..... 22mA
- Battery charge voltage ..... 13.6V
- Alarm 1 and Alarm 2 silencing time ..... 15mins, 1hr, 2hrs or 4hrs
- Power LED flash rate ..... once every 3 seconds (approx.)
- External alarm siren rating ..... 200mA @ 9V

*By JOHN CLARKE*

**arms**

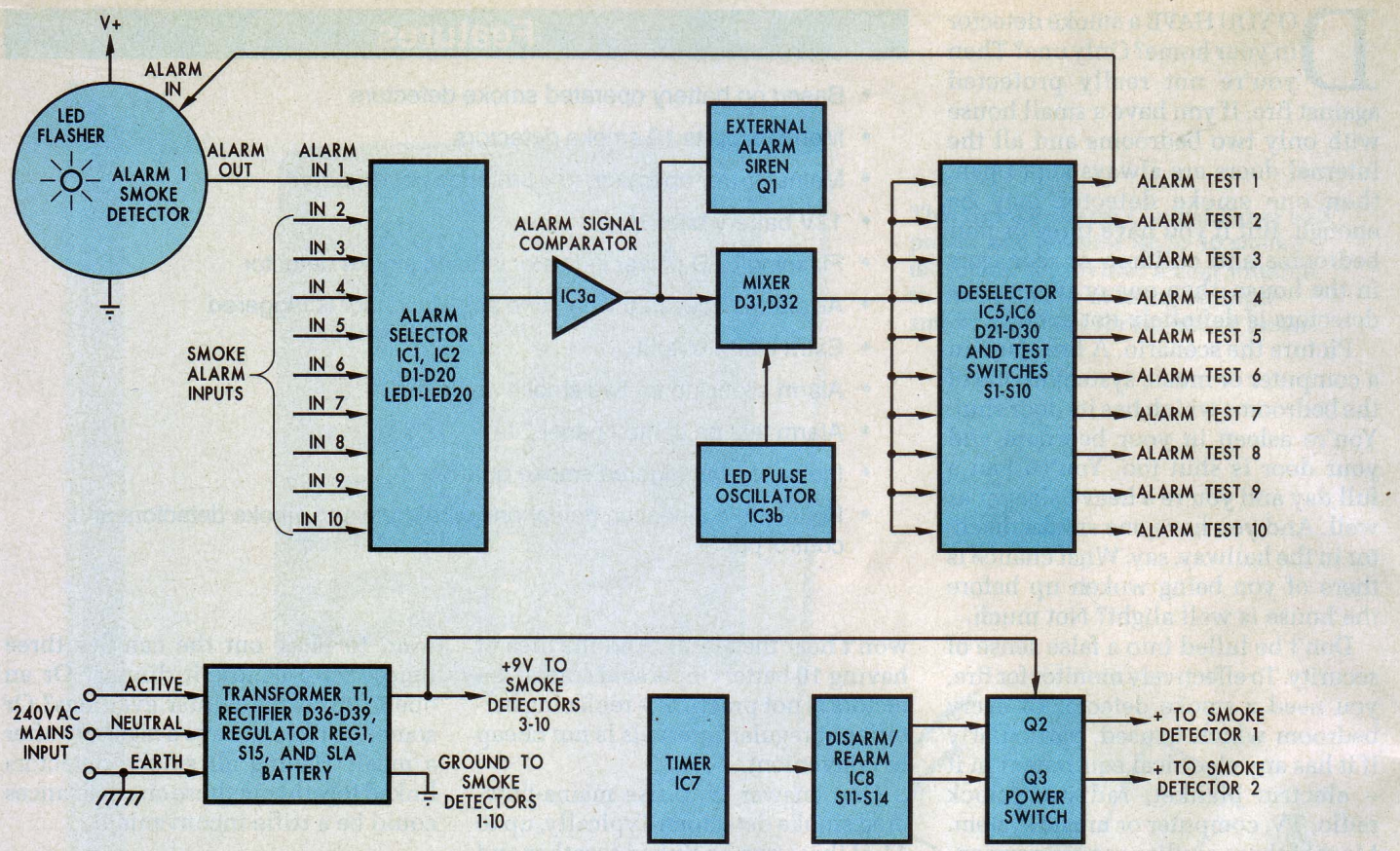



**Fig.1: block diagram for the Smoke Alarm Control Panel. There is provision for up to 10 smoke detectors to be connected to the unit and these can be wired via 4-way telephone cable.**

be rearmed automatically or you can rearm them by pushing a button on the Control Panel. So you can have that birthday party with lots of candles after all.

There is also provision to connect a piezo siren in the roof. That way, if a fire starts when you're outside the house or not at home, your neighbours can be alerted.

Each smoke detector has its battery removed and a small PC board installed in its place. The board accommodates a diode, two transistors and a LED which flashes every three seconds to indicate that the detector is powered – no more need to check each smoke detector. If a detector is disarmed, the LED does not flash. Alternatively, when the alarm is sounding, the LED lights continuously.

## Control panel

The SILICON CHIP Smoke Alarm Control Panel is designed to be mounted vertically on a wall and we assume that normally it will be installed out of view, inside a closet.

The control panel has test switches for all 10 smoke detectors plus the disarm and rearm facility for two detectors. In normal operation, each detector is polled (monitored) for 0.7 seconds and its respective LED lights during that time. If a detector is activated by smoke, its control panel LED remains lit until the smoke has cleared.

## Block diagram

Fig.1 shows the block diagram of the Smoke Alarm Control Panel. Only one smoke detector is shown out of a possible 10 which can be connected. There are four wires to each smoke detector: +9V, 0V, alarm test input and alarm output.

The alarm output from the smoke detector indicates the presence of smoke or if the test switch has been pressed. This signal is applied to the alarm selector (IC1, IC2, etc) which monitors each of the smoke detectors in sequence. If the selected smoke detector gives an alarm signal, comparator IC3a will produce an output to power the external alarm siren via transistor Q1. This output is also fed to a deselector (IC5, IC6, etc) via a mixer (D31, D32).

The deselector sends an alarm signal to the inputs of all smoke detectors except for the one selected. Thus all smoke detectors will sound the alarm if one alarm is activated. When the smoke clears, all smoke detector alarms will stop.

The deselector serves one important function. By sending the alarm signal to all but the smoke detector which originated the alarm, all alarms stop when the smoke clears. Otherwise, if the detector which initiated the alarm also had the alarm signal fed to its input, the alarms would not stop until the power was disconnected.

Power for the unit is derived from the mains while an SLA (sealed lead acid) battery provides backup in the event of a blackout. The +9V supply connects to smoke detectors 3-10, while detectors 1 & 2 are supplied via transistors Q2 and Q3. When the disarm switches are pressed for detector 1 or 2, the +9V supply is disconnected for the time set by timer IC7.

Detectors 1 & 2 can be independently disarmed or rearmed. However, the disarm time is preset from the time the disarm switch for either detector is pressed.

The disarm time can be set at 15 minutes, 1hr, 2hrs or 4hrs and is set by a link on the PC board. The Australian Standard (AS3786-1993) speci-

## PARTS LIST

1 PC board, code 03312961, 149 x 251mm
1 PC board, code 03312962, 112 x 151mm
1 Dynamark front panel label, 127 x 144mm
1 label for control panel terminals
1 plastic case, 180 x 260 x 65mm, Jaycar Cat HB-5974 or equivalent
1 2155 transformer, 15V at 1A (T1)
1 1.2AH 12V SLA battery
1 250VAC 3-core mains cord and moulded 3-pin plug
1 2AG panel fuse holder and 250mA fuse (F1)
1 DPST mains switch with Neon lamp (S15)
1 solder lug
1 cordgrip grommet for mains cord
12 grey momentary contact snap action PC board switches (S1-S11 & S13)
2 green momentary contact snap action PC board switches (S12,S14)
1 mini-U heatsink, 25 x 30 x 16mm
3 10-way PC board terminal strips
1 12-way PC board terminal strip
2 7-way pin header sockets and plugs (can use 8-way)
2 6-way pin header sockets and plugs
1 380mm length of 6-way rainbow cable
1 650mm length of 7-way rainbow cable
1 50mm length of heavy duty green hookup wire (battery connection)
1 50mm length of heavy duty red hookup wire (battery connection)
1 150mm length of medium duty hookup wire
2 spade crimp lugs for SLA battery terminals
10 small cable ties
10 3mm diameter x 5mm screws to secure main PC board
2 4mm screws and nuts plus star washers for transformer mounting
1 3mm dia x 6mm screw and nut for regulator mounting
4 3mm dia x 10mm screws for front panel PC board mounting
4 6mm untapped spacers for front panel PC board
1 400mm length of 0.8mm tinned copper wire
5 PC stakes
12 3mm LED bezels

**Semiconductors**
2 7555, LMC555CN, TLC555CN CMOS timers (IC1,IC4)
1 4017 decade counter (IC2)
1 LM393 dual comparator (IC3)
2 4049 hex buffers (IC5,IC6)
1 4040 binary counter (IC7)
1 4013 dual D-flipflop (IC8)
3 BC328, BC327 PNP transistors (Q1-Q3)
35 1N914, 1N4148 signal diodes (D1-D35)
7 1N4004 1A diodes (D36-D42)
1 13V 1W zener diode (ZD1)
1 LM317T 1A adjustable regulator (REG1)
10 3mm green LEDs (LED1-LED10)
2 3mm red LEDs (LED11,LED12)

**Capacitors**
2 2200µF 25VW PC electrolytic
5 100µF 16VW PC electrolytic
1 33µF 16VW PC electrolytic
7 10µF 16VW PC electrolytic
2 1µF 16VW PC electrolytic
1 .01µF MKT polyester
1 .0015µF MKT polyester

**Resistors** (0.25W 1%)
2 470kΩ
3 1kΩ
10 100kΩ
1 47kΩ
3 33kΩ
25 10kΩ
3 2.2kΩ
1 680Ω
1 180Ω 5W
1 120Ω
1 100Ω

**Miscellaneous**
Heatshrink tubing, Blu-Tack® adhesive, solder

### Smoke Alarm PC board (one per smoke detector)

1 Kambrook SD28 ionisation smoke alarm or equivalent
1 PC board, code 03312963, 46 x 23mm
1 label to indicate terminal connections
1 label "No user serviceable parts inside"
1 self-tapping mounting screw
1 4-way PC mounting terminal strip
1 5mm LED bezel
4 PC stakes
1 crocodile clip

**Semiconductors**
1 BC548 NPN transistor (Q4)
1 BC328 NPN transistor (Q5)
1 1N914 signal diode (D43)
1 5mm red LED (LED13)

**Capacitors**
1 47µF 16VW PC electrolytic capacitor
1 10µF 16VW PC electrolytic capacitor

**Resistors** (0.25W 1%)
1 1MΩ
1 100kΩ
1 33kΩ
1 10kΩ
1 1kΩ

**Miscellaneous**
1 100mm length of yellow hookup wire
1 100mm length of green hookup wire

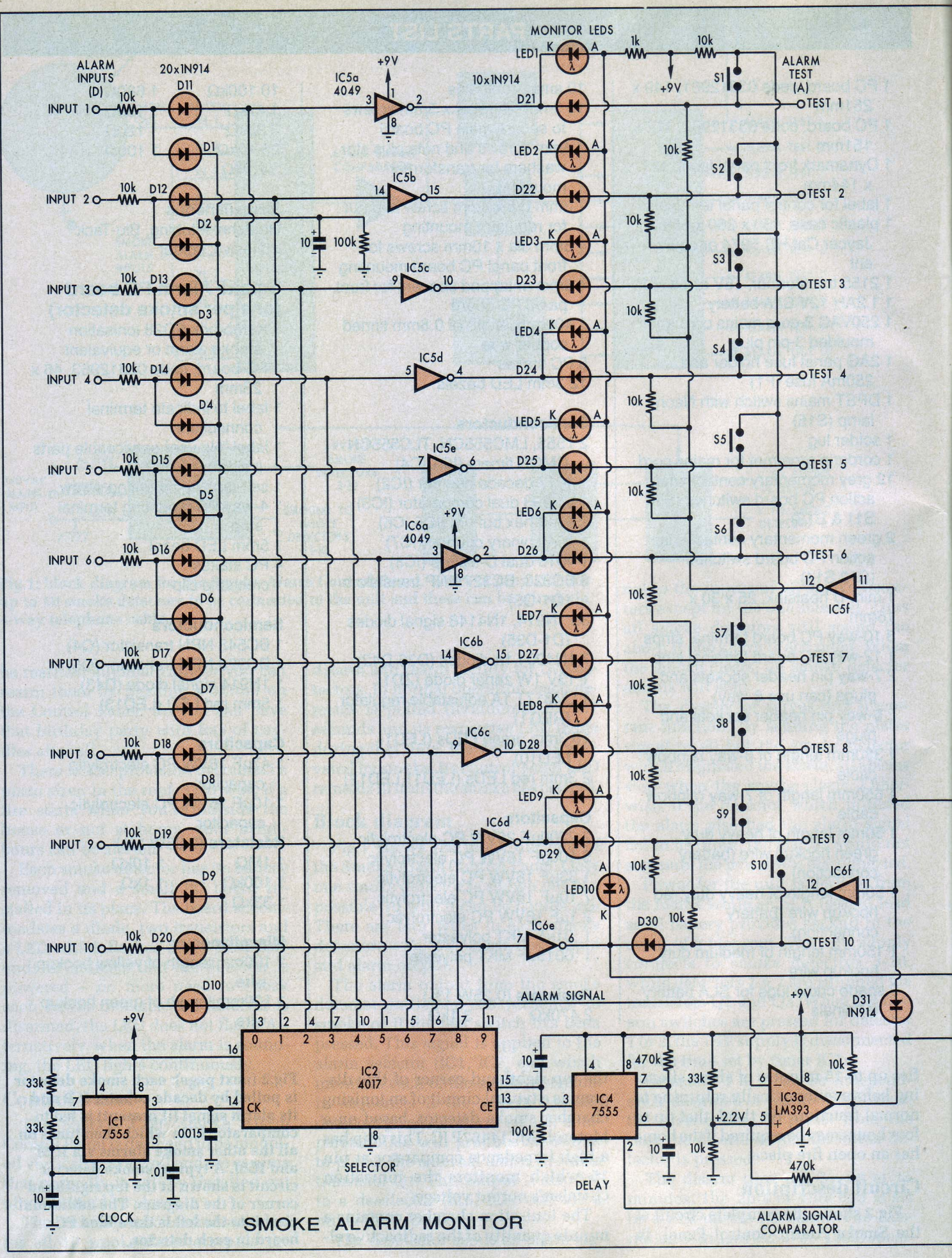
fies up to 15 minutes of alarm silencing before automatically returning to normal function. We think that up to four hours may be required if the home has an open fire place.

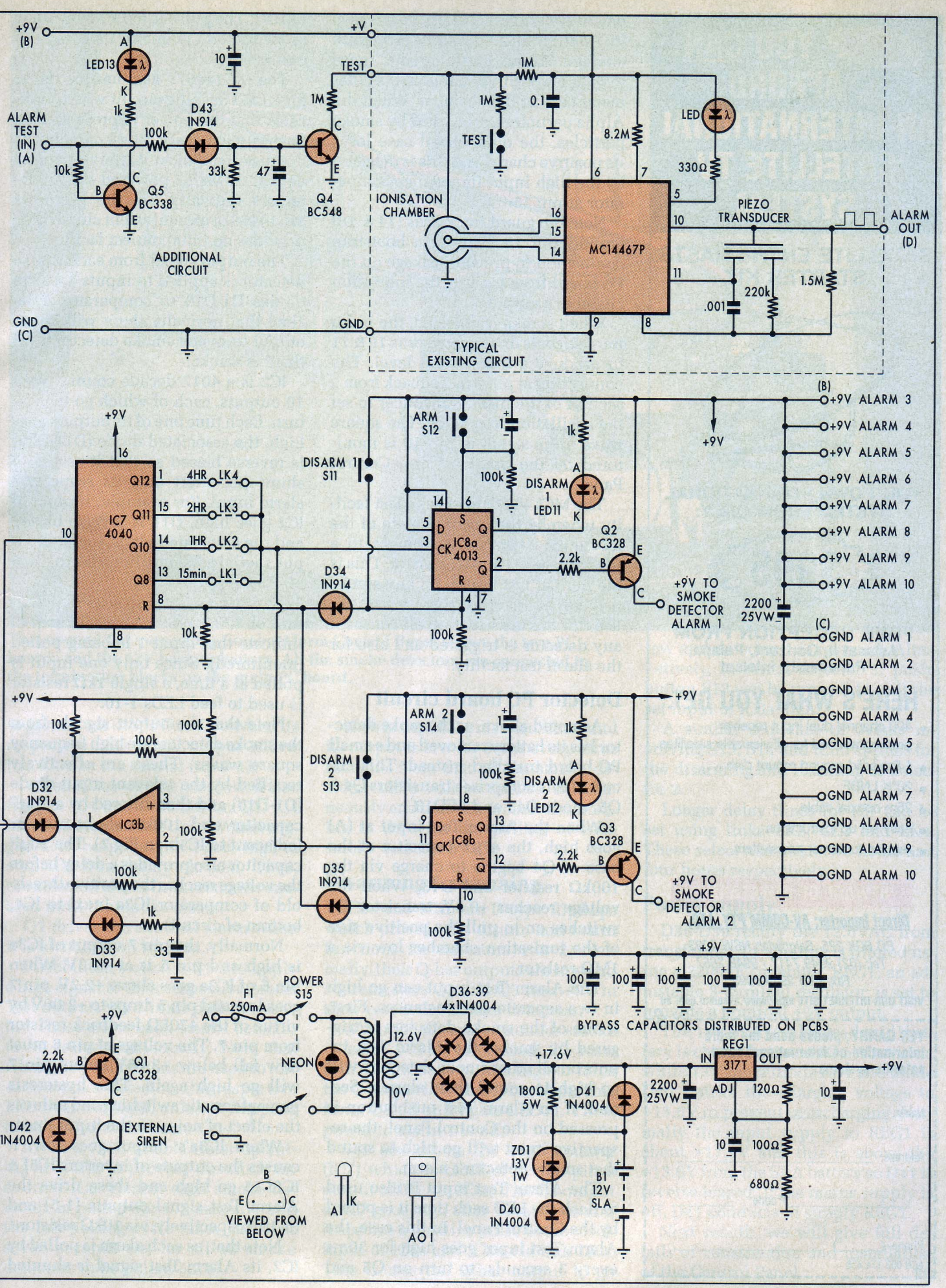
## Circuit description

Fig.2 shows the complete circuit of the Smoke Alarm Control Panel. In the top righthand corner of this diagram is a typical circuit of an ionising chamber smoke detector, based on a Motorola MC14467P IC. This chip has a high impedance comparator at pin 15 which monitors the ionisation chamber's output voltage.

The ionisation chamber contains a minute quantity of the radioactive el-

**Fig.2 (next page): each smoke detector is polled by decade counter IC2 and its alarm signal (if present) is fed to comparator IC3a which then turns on all the other smoke alarms via IC5f and IC6f. A typical smoke detector circuit is shown at the top righthand corner of the diagram. The additional circuit to the left is the added PC board in each detector.**


ALARM INPUTS (D)
20x1N914
MONITOR LEDS
10x1N914
ALARM TEST (A)
INPUT 1
INPUT 2
INPUT 3
INPUT 4
INPUT 5
INPUT 6
INPUT 7
INPUT 8
INPUT 9
INPUT 10
TEST 1
TEST 2
TEST 3
TEST 4
TEST 5
TEST 6
TEST 7
TEST 8
TEST 9
TEST 10
IC5a 4049
IC5b
IC5c
IC5d
IC5e
IC5f
IC6a 4049
IC6b
IC6c
IC6d
IC6e
IC6f
+9V
ALARM SIGNAL
IC1 7555
IC2 4017
IC3a LM393
IC4 7555
SELECTOR
DELAY
CLOCK
ALARM SIGNAL COMPARATOR
SMOKE ALARM MONITOR


+9V (B)
LED13
10
TEST
+V
1M
1M
0.1
LED
ALARM TEST (IN) (A)
1k
D43 1N914
100k
1M
8.2M
330Ω
10k
33k
47
Q5 BC338
Q4 BC548
TEST
IONISATION CHAMBER
MC14467P
PIEZO TRANSDUCER
ALARM OUT (D)
ADDITIONAL CIRCUIT
220k
1.5M
.001
GND (C)
GND
TYPICAL EXISTING CIRCUIT
(B)
+9V ALARM 3
+9V ALARM 4
+9V ALARM 5
+9V ALARM 6
+9V ALARM 7
+9V ALARM 8
+9V ALARM 9
+9V ALARM 10
ARM 1 S12
DISARM 1 S11
DISARM 1 LED11
IC7 4040
4HR LK4
2HR LK3
1HR LK2
15min LK1
IC8a 4013
Q2 BC328
2.2k
D34 1N914
+9V TO SMOKE DETECTOR ALARM 1
2200 25VW
(C)
GND ALARM 1
GND ALARM 2
GND ALARM 3
GND ALARM 4
GND ALARM 5
GND ALARM 6
GND ALARM 7
GND ALARM 8
GND ALARM 9
GND ALARM 10
ARM 2 S14
DISARM 2 S13
DISARM 2 LED12
IC8b
Q3 BC328
D35 1N914
+9V TO SMOKE DETECTOR ALARM 2
D32 1N914
IC3b
D33 1N914
33
100
BYPASS CAPACITORS DISTRIBUTED ON PCBS
F1 250mA
POWER S15
NEON
D36-39 4x1N4004
12.6V
0V
+17.6V
REG1 317T
IN
OUT
ADJ
180Ω 5W
D41 1N4004
120Ω
100Ω
680Ω
ZD1 13V 1W
B1 12V SLA
D40 1N4004
Q1 BC328
D42 1N4004
EXTERNAL SIREN
VIEWED FROM BELOW
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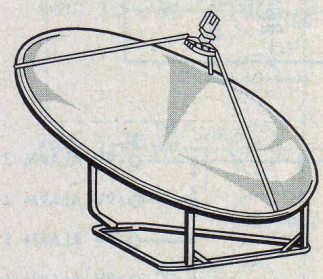

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ement Americium 241. As this decays (to Neptunium 237) it emits positively charged Alpha particles and these maintain a positive charge on the outer metal case of the chamber. When the Alpha particles are blocked by smoke particles, the outer metal case loses its positive charge and this is detected by the high input impedance comparator at pin 15.

Note the guard track pins (14 & 16) around pin 15. This is a bootstrap connection to prevent leakage on the PC board from loading the ionisation chamber's output.

When smoke is detected, the piezo transducer is driven from pins 10 & 11 to produce a high sound level. The connection at pin 8 is feedback from a section of the piezo transducer to set the oscillation frequency. The square wave drive signal at pin 10 is monitored by the Smoke Alarm Control Panel.

The MC14467P also has a test facility whereby the positive plate of the ionisation chamber is brought to a low voltage via a 1MΩ resistor. This is the normal test button on any smoke detector and it sounds the alarm. We use this feature to set off all alarms if any detector is triggered and also for the alarm test facility.

## Detector PC board circuit

As noted above, each smoke detector has its battery removed and a small PC board installed instead. This circuit of this comprises transistors Q4 & Q5, diode D43 and LED13.

When the Alarm Test input at (A) goes high, the 47µF capacitor at the base of Q4 begins to charge via the 100kΩ resistor and D43. When the voltage reaches +0.6V, transistor Q4 switches on to pull the positive side of the ionisation chamber low via a 1MΩ resistor.

The Alarm Test input can go high in two separate circumstances. First, if one of the smoke detectors is triggered by smoke, the Alarm Test inputs on all other smoke detectors will go high to sound their alarms. Second, if an Alarm Test pushbutton is pressed on the Control Panel, the respective input will go high to sound that smoke detector's alarm.

The Alarm Test input is also used to flash the LED each time it is polled by the Control Panel. In this case, the Alarm Test input goes high for 30ms every 3 seconds, to turn on Q5 and LED13. The pulse is too short at 30ms to switch on Q4 due to its delay circuitry.

The MC14467P also has provision for a LED flashing circuit which indicates that the power is present. This flashes once every 40 seconds but is not used on most battery-operated detectors. Mains powered smoke detectors typically use the Motorola MC14468 or an equivalent chip which provides an interconnect facility.

The output signal from each smoke detector is applied to inputs 1-10 via diodes D1-D10 to comparator IC3a. Note that normally there will be no output from any smoke detector until there is smoke!

IC2 is a 4017 decade counter with 10 outputs, each of which go high in turn. Each time one of its outputs goes high, the associated diode (D11-D20) is reverse biased so that it ceases to shunt (ie, short out) its respective alarm input. For example, if pin 3 of IC2 goes high, D11 is reverse biased and the associated alarm signal at input 1 will be fed via diode D1 to pin 6 of IC3a.

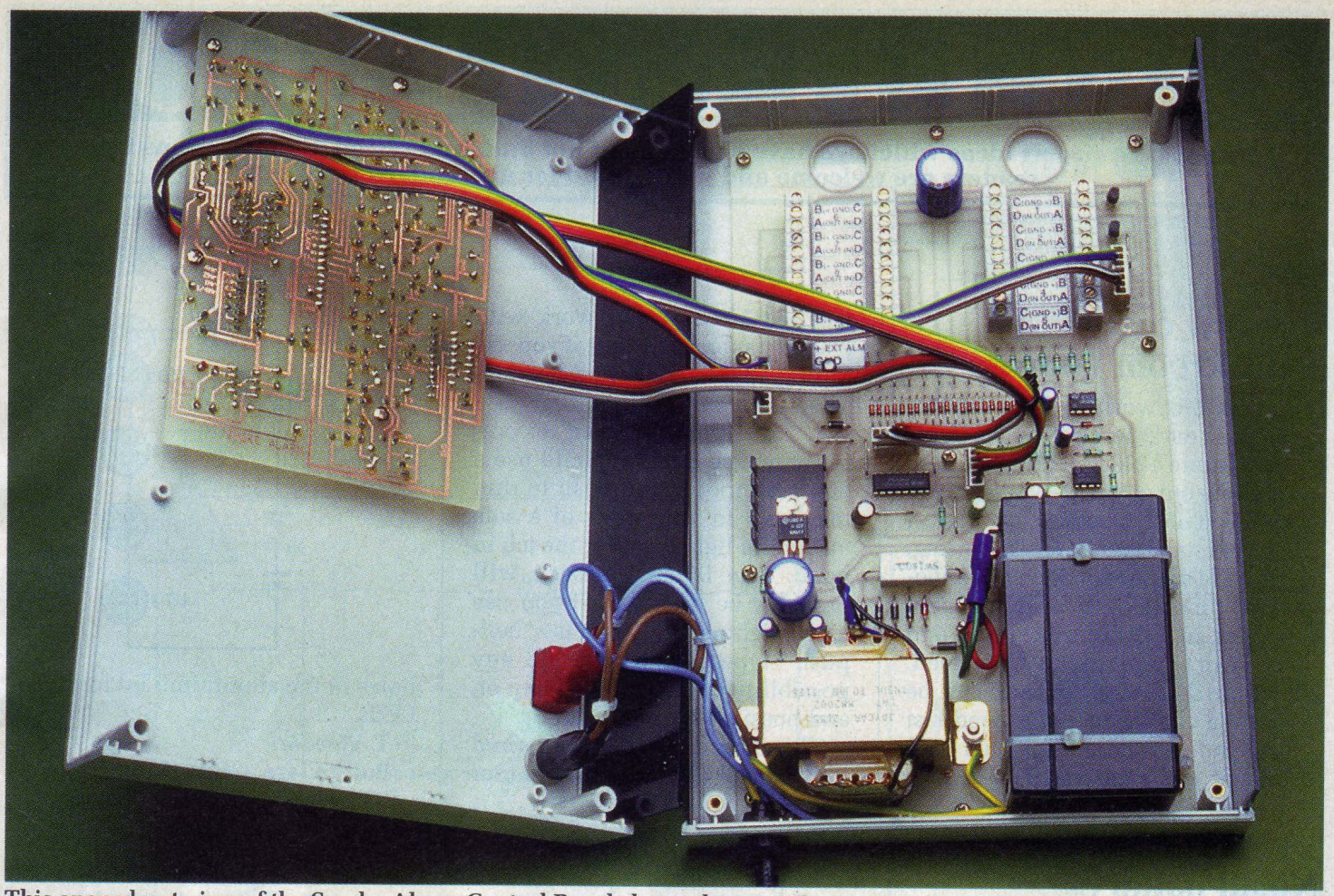
At the same time, inverter IC5a will turn on LED1 on the Control Panel to indicate that input 1 is being polled (monitored). Since only one input is polled at a time, a single 1kΩ resistor is used to feed LEDs 1-10.

Note that the output signals from the smoke detectors are high frequency square waves. These are effectively rectified by the relevant input diode (D1-D10) and then filtered by a 10µF capacitor and 100kΩ shunt resistor (adjacent to IC5b on Fig.2). The 10µF capacitor also provides a delay before the voltage reaches the positive threshold of comparator IC3a (next to IC4, bottom of circuit).

Normally, the pin 7 output of IC3a is high and pin 5 is at +2.2V. When pin 6 of IC3a goes above +2.2V, pin 7 goes low and pin 5 drops to +2.06V by virtue of the 470kΩ feedback resistor from pin 7. The voltage at pin 6 must now fall below +2.06V before pin 7 will go high again. This hysteresis prevents erratic switching and reduces the effect of noise on the input lines.

When IC3a's output goes low, it causes the outputs of inverters IC5f & IC6f to go high and these drive the Alarm Test signal outputs (1-5) and (6-10) respectively, via 10kΩ resistors.

Note that, as each alarm is polled by IC2, its Alarm Test signal is shunted



**This opened-out view of the Smoke Alarm Control Panel shows the two PC boards and the 12V backup battery. All the smoke detectors are connected to the termination blocks on the main PC board.**

to ground via diode D21-D30 when its respective LED driver output is low (eg, IC5a in the case of input 1).

When IC3a's output goes low, it also triggers IC4 and switches on Q1. IC4 is a 7555 monostable timer. When triggered, its output at pin 3 goes high to stop IC2 from being clocked. Thus, the selected alarm input remains enabled until the smoke clears.

Q1 drives the external alarm when it is switched on by IC3a.

Pushbutton switches S1-S10 apply a high signal to their respective Alarm Test outputs via a 10kΩ pull-up resistor. These allow each smoke detector to be tested individually. Note that when the pushbuttons are used to test each smoke detector, the respective LED does not light, unless it happens to be polled at the same time.

IC1 is a 7555 astable timer operating at 1.4Hz to provide the clock for counter IC2. Hence, each smoke detector is polled for 0.7 seconds and the full polling cycle takes just over seven seconds (ie, for all 10 smoke detectors to be polled once).

IC3b is the LED pulse oscillator and its output is low for 30ms every three seconds. Note that all ten smoke detector LEDs will be flashed simultaneously and that this process has nothing to do with the polling of each smoke detector by IC2.

## Disarming & rearming

IC8a and IC8b are D-type flipflops which provide the disarm and rearm functions for detectors 1 & 2. Normally, their Q-bar outputs are low and so transistors Q2 and Q3 feed +9V to their respective smoke detectors.

When the disarm switch for smoke detector 1 (S11) is pressed, the reset (pin 4) of IC8a is pulled high to force the Q output low and Q-bar high. This turns Q2 off and lights LED11. Thus, power to alarm 1 is off.

S11 also resets the 4040 counter (IC7) which is clocked by the pin 9 output of IC2 via IC6e. The Q8 output of IC7 goes high after 15 minutes and it applies a positive pulse to the clock input of IC8a and IC8b via link LK1. This causes the Q-bar output to go low and detector 1 is rearmed. Alternatively, to rearm detector 1, pushbutton S12 can be pressed to pull the set input of IC8a high.

A similar sequence of events involving S13, S14 and IC8b applies for the disarming and rearming of detector 2.

Longer delay times for IC7 can be set using links LK2, LK3 and LK4. These select one hour, two hours and four hours respectively.

## Power supply

D36-D39 rectify the 12.6VAC from transformer T1 and this is filtered using a 2200µF capacitor. REG1, an adjustable 3-terminal regulator, is set to provide a nominal +9V output.

The 12V SLA (sealed lead acid) battery is charged via a 180Ω 5W resistor, while 13V zener diode ZD1 and diode D40 restrict the charging voltage to +13.6V to prevent overcharging. Normally the input supply to REG1 is about +17.7V and this is above the +13.6V from the SLA battery so D41 is reverse biased. If the mains supply is off, D41 conducts to supply REG1.

Next month, we will give full details of construction and installation of the Control Panel. **SC**

# CIRCUIT NOTEBOOK

**Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.**

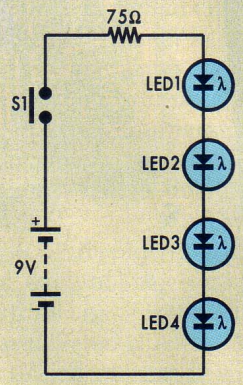
## A low cost darkroom lamp

Anyone working in a photographic darkroom gets into a situation where a piece of photographic paper is out of its safety wrappings and you need to make quite sure of an enlarger lens aperture setting, find the scissors or check an exposure time (maybe read the next setting in a list of trial times) and you can't quite see what you need.

Putting the paper back can be quite a challenge – you need fast and *safe* illumination. This LED circuit is the answer. You can select red LEDs if you work with graded papers or orange if you use Multigrade materials. Power is supplied from a 9V battery.

A 75Ω resistor is used for current limiting but you could use a 200Ω trimpot if you wish to dim the lamp to your idea of a safe minimum light level for the job in hand. The latter approach will probably be necessary if you use high-brightness LEDs. S1 is a "bell-push" type switch to avoid any possibility of leaving the lamp on and possibly fogging a film.

The circuit can be hardwired into a small plastic case with four holes in the aluminium lid for the LEDs.




**T. Weedon,**
**Point Clare, NSW. ($15)**

## Nicad battery discharger has capacity indication

In the process of charging and discharging nicad batteries it is useful to know the capacity of a battery and this unit provides that information indirectly.

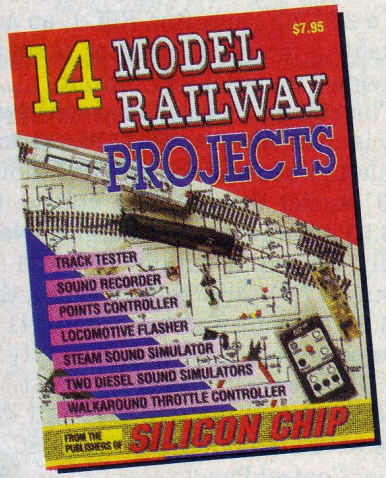
Essentially, this unit is a battery discharger combined with a timer which records the time taken for the battery to discharge to the "end point" voltage. Knowing the time and the discharge current, it is possible to calculate the battery capacity in amp-hours.

The battery discharger has a selection of 11 discharge voltages ranging from 1.1V to 12.1V in 1.1V steps (ie, 1.1V per cell) and with various discharge rates. The timer measures in minutes to 999 (ie, up to 16 hours and 39 minutes) using 12 LEDs for simplicity and economy.

A 9V DC plugpack powers the circuit although it normally delivers about 13V DC. When power is first applied, LED1 will be on and also various timer LEDs will be on. Pushing the Reset switch S7 clears the timer and all LEDs should go out. The discharge voltage should be set to suit the nicad battery and the discharge cycle is initiated by pushing the start button S1.

This will connect the battery and provided the correct discharge voltage has been selected, pin 2 of comparator IC1 will be above pin 3 and so pin 7 will be high, turning on transistor Q1 and the relay. The relay maintains the battery connection and also

*continued next page*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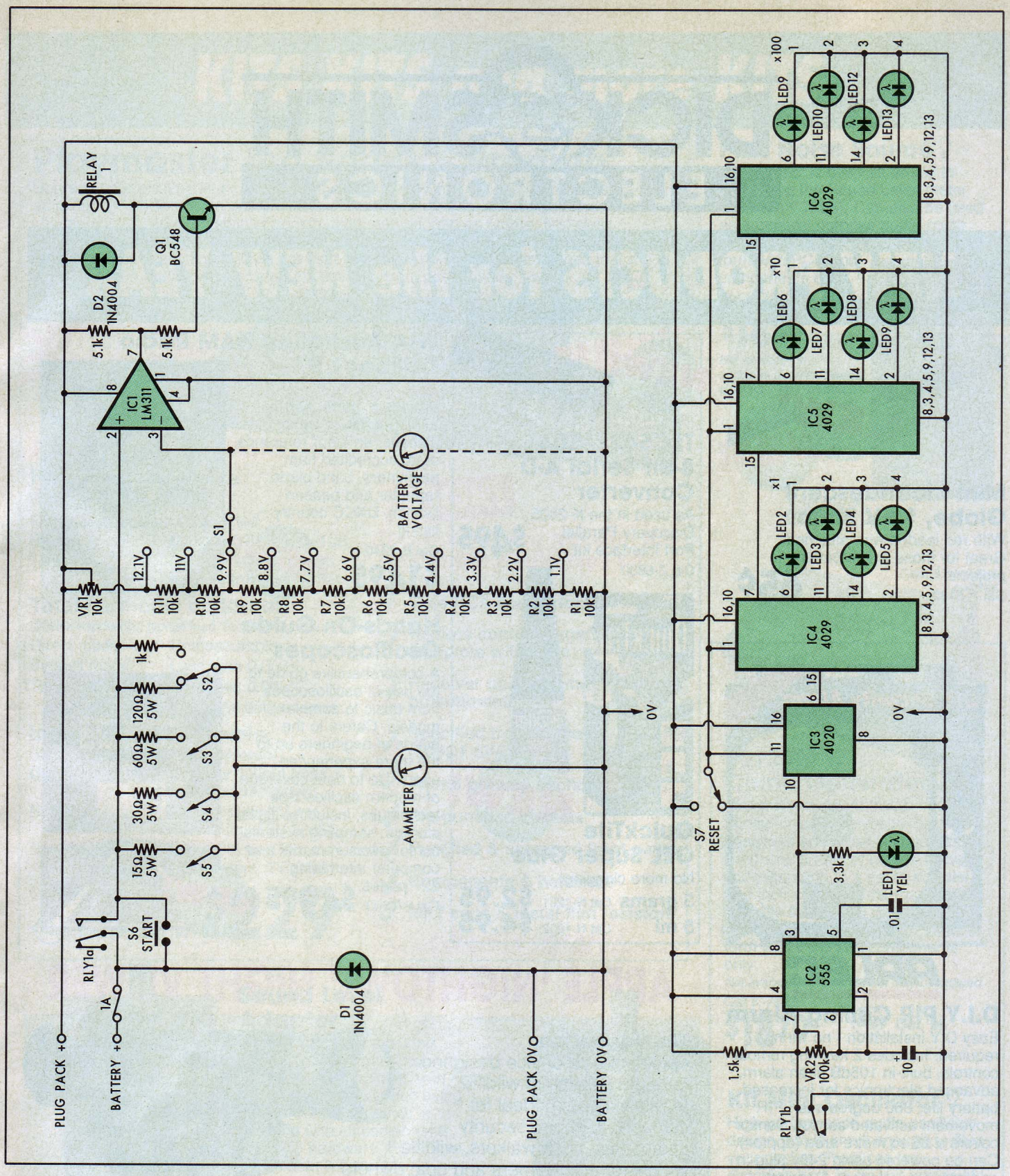


enables the astable timer IC2.

IC2 provides pulses at slightly less than one-second intervals and these are fed to IC3, a 4020 which divides by 64 to provide pulses at one-minute intervals. From there, IC4, IC5 and IC6 provide a three-stage counter which will count up to 999 minutes.

When the battery reaches the discharge voltage, pin 2 of IC1 drops below pin 3, thereby causing pin 7 to go low and turn off Q1 and the relay. The load is disconnected from battery and the counter is stopped because IC2 ceases to oscillate.

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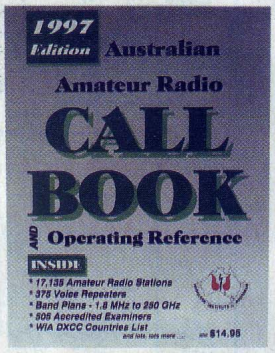


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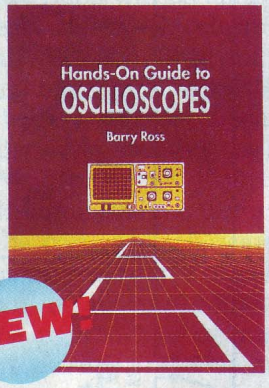


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| | |
|---|---|
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(20kHz bandwidth, typical load, at 1VRMS output)

| | |
|---|---|
| Direct mode: | Unmeasurable |
| Bypass mode: | Less than 0.002% |
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**Input and output levels**
(Volume control at maximum, line inputs)

| | |
|---|---|
| Direct mode: | 1V in for 1V out (max output: unrestricted) |
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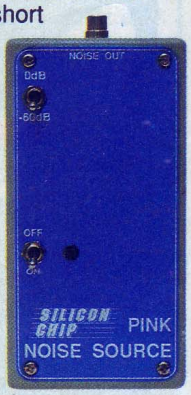


SILICON CHIP Jan '97

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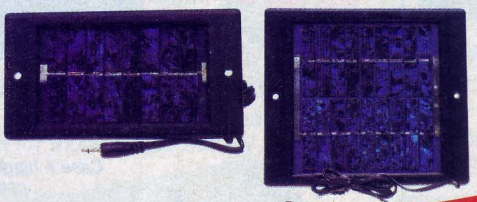

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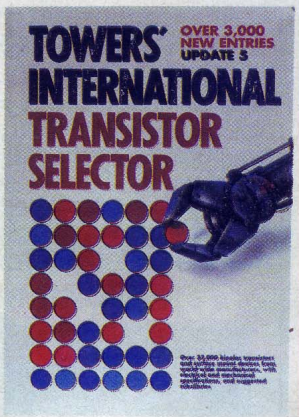


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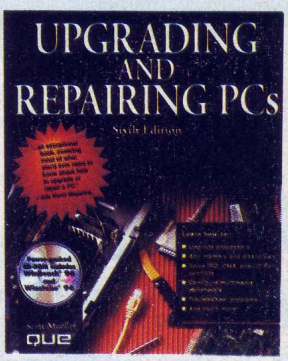


- Shifts the focus from IBM PCs to Intel-based systems
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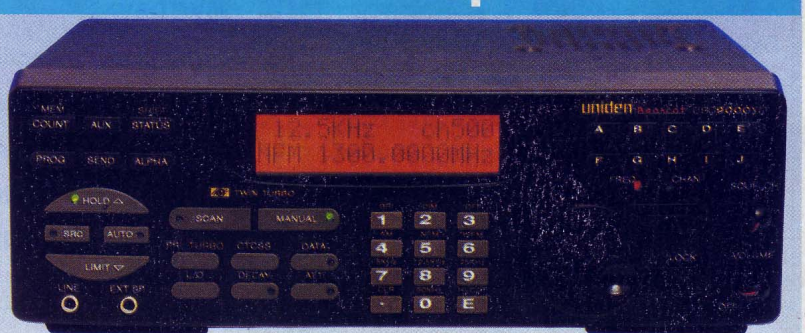
## 9000XLT Desktop Scanner

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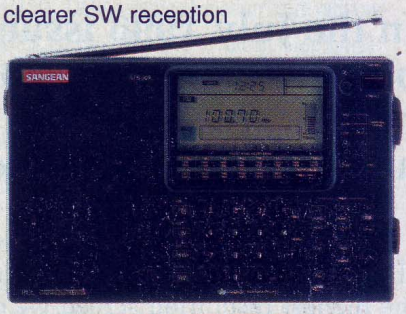


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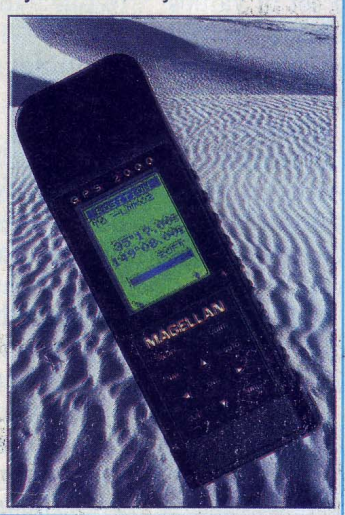


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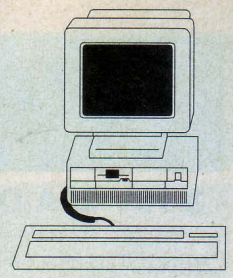
# COMPUTER BITS

BY RICK WALTERS



# Drawing circles in GW-Basic

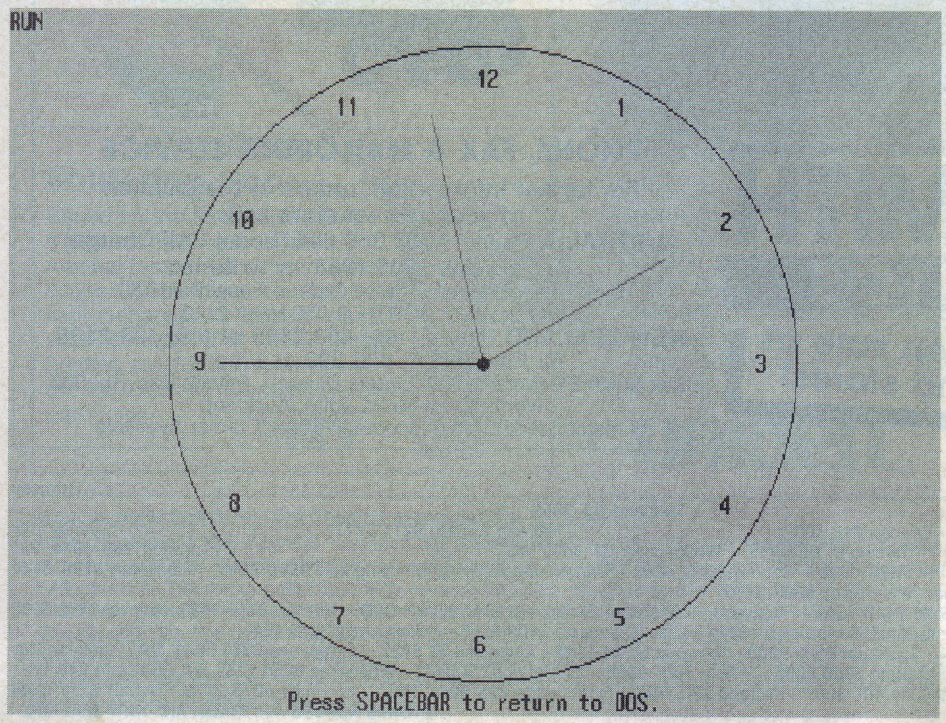
**In the July 1996 issue, we discussed drawing borders on the screen using GW-Basic. This month, we will show you how to draw an analog clock on the screen.**

To draw circles, or for any acceptable current graphics, we need to use the highest resolution screen we can access. This is SCREEN 9 in GW Basic. Next we need to choose some colours that look effective. You can play around with the COLOR statement on line 1270 but be careful. Black on black is very hard to see!

If we want to draw an analog clock face the first step is to draw a circle. This is done with the CIRCLE statement on line 2030. You will notice that we have not used numeric values for the circle centre and radius but values we have defined previously in the INIT subroutine.

As we will have to use these values again in the "update hands" subroutine, if we need to re-position the clock on the screen it is only necessary to change this one set of values on line 1080, rather than trying to find all the lines where the values were used.

Perhaps we should elaborate on SCREEN 9 at this point. It consists of 640 x 350 pixels for drawing graphics but at the same time allows you to print text on an 80 x 25 grid. Thus, each character will occupy (640/80) = 8 pixels by (350/25) = 14 pixels. We can't draw graphics on the 25th line, although we can place text there.




Once we have drawn the circle and it looks about the right diameter, we have to calculate the position of each of the numbers which are placed every 30° around the circle. This is done using the formula on line 2050, which calculates the sine and cosine of the angle and locates the cursor at that point ready to print the number.

So far we have a clock face, now for some hands. How do we know where to place them?

PRINT TIME$ in Basic looks at the computer's internal clock and prints this time, so if we use this function our clock will be as accurate as the computer's is. Line 1260 dissects the time readout and defines the three parameters we are interested in: hours, minutes and seconds. By defining them as functions (DEF FN) they are available immediately; we don't have to access the time and dissect it each time we need it.

To synchronise the analog clock time to the computer we save the current second in line 3040 and wait until the next second begins. Initially there are no hands drawn, but once they are drawn they have to be erased and re-drawn every second. This is done in lines 3070-3120.

To finish off we draw a couple of small circles at the centre of the face in line 3130.

Right, you now have the bare bones clock which is capable of displaying and updating the time. If you want to improve it, add the individual minutes between the five minute marks and perhaps make the face a different colour to the surrounding screen. Look up your Basic manual for more information on color.

Next time we will discuss sequential and random access files and the methods used for storing and retrieving data. **SC**

```
1 GOTO 10
2 GOSUB 1890: LPRINT TAB(55);" Printed on ";TODAY$
3 LLIST
4 END
5 SAVE "C:\clock",A 'Save file on C drive
6 SAVE "B:\clock",A 'Save file on B drive
7 END
10 REM Draw analog clock on screen
11 REM run 2 will print listing on printer
12 REM run 5 will save program to drive C
13 REM run 6 will save program to drive B (change to A if required)
14 REM GOSUB 1900 Will clear from current cursor line to Line 24
20 GOSUB 1030 'Initialise
30 GOSUB 2030 'Draw face
40 GOSUB 3050 'Draw current time
50 GOSUB 3030 'Erase & update hands
60 LOCATE 25,1: PRINT FNCENTRE$("Press SPACEBAR to return to
   DOS.");
70 K = INKEY$: IF K < > "" THEN 999
80 GOTO 50
999 END'SYSTEM 'Erase END' when running OK
1000 '**********************
1010 'Initialisation routine.
1020 '**********************
1030 KEY OFF: DEFINT A-Z: DEFSTR D,E,K,U: DEFSNG P,S,C
1040 TODAY = VAL(MID$(DATE$,4,2))
1050 ESC = CHR$(27): ENTER = CHR$(13): KSP = CHR$(32) 'Spacebar
1060 KLA = CHR$(0) + CHR$(75): KRA = CHR$(0) + CHR$(77) 'Left &
   right arrows
1070 KUA = CHR$(0) + CHR$(72): KDA = CHR$(0) + CHR$(80) 'Up &
   down arrows
1080 KPU = CHR$(0) + CHR$(73): KPD = CHR$(0) + CHR$(81) 'Page up
   & down
1090 KHOME = CHR$(0) + CHR$(71): KEND = CHR$(0) + CHR$(79)
   'Home & end
1100 DATA January, February, March, April, May, June, July
1110 DATA August, September, October, November, December
1120 DIM MONTH$(12): FOR A = 1 TO 12: READ A$: MONTH$(A) = A$:
   NEXT
1130 MONTH$ = MONTH$(VAL(LEFT$(DATE$,2))) 'Current month
1140 DEF FNCENTRE$(M$) = SPACE$((79 - LEN(M$))/2) + M$ 'Centre
   text
1150 DEF FNCEOL$ = STRING$(79 - POS(Q)," ")
1160 DEF FNYN = INSTR((" YyNn") + ENTER + ESC,INKEY$)
1165 '0 or 1, no key, 2 or 3 - Y, 4 or 5 - N, 6 - enter, 7 - escape
1170 ULT = CHR$(218): DLT = CHR$(201): URT = CHR$(191): DRT =
   CHR$(187)
1175 'Singe & Double Left & Right top corners
1180 ULB = CHR$(192): DLB = CHR$(200): URB = CHR$(217): DRB =
   CHR$(188)
1185 'Singe & Double Left & Right bottom corners
1190 UH = CHR$(196): DH = CHR$(205): UV = CHR$(179): DV =
   CHR$(186)
1195 'Single & Double Horizontal & vertical lines
1200 ULI = CHR$(195): DLI = CHR$(204): URI = CHR$(180): DRI =
   CHR$(185)
1205 'Single & Double Left & Right intersections
1210 UTI = CHR$(194): DTI = CHR$(203): UBI = CHR$(193): DBI =
   CHR$(202)
1215 'Single & Double Top & Bottom intersections
1220 UCI = CHR$(197): DCI = CHR$(202) 'Single & Double Centre
   intersection
1230 PI = 3.14159: BH = 8: RH = 4 'Black & red hands
1240 DEF FNS(X) = SIN (X * PI/180) 'Define sine function from radians
1250 DEF FNC(X) = COS (X * PI/180) 'Define cosine function from radians
1260 DEF FNHR$ = LEFT$(TIME$,2): DEF FNMIN$ = MID$(TIME$,4,2):
   DEF FNSEC$ = RIGHT$(TIME$,2)
1270 SCREEN 9: FC = 4: BC = 7: COLOR FC,BC 'Fore & background
1280 YC = 175: XC = 325: RAD = 215 'Circle centre & radius
1890 TODAY$ = MID$(DATE$,4,2) + "-" + LEFT$(DATE$,2) + "-" +
   RIGHT$(DATE$,2)
1899 RETURN
1900 '**********************************
1910 'Clear to end of screen subroutine.
1920 '**********************************
1930 VIEW PRINT CSRLIN TO 24: CLS: VIEW PRINT
1999 RETURN
2000 '****************
2010 'Draw clock face.
2020 '****************
2030 CIRCLE (XC,YC),RAD 'Draw circle centre XC,YC radius RAD
2040 FOR A = 1 TO 12
2050 LOCATE 13 - 10 * FNC(30 * A),40 + 24 * FNS(30 * A) 'Calculate
   position
2060 PRINT A;: NEXT 'write numbers
2099 RETURN
3000 '*************
3010 'Update hands.
3020 '*************
3030 OLDSEC = VAL(FNSEC$): OLDMIN = VAL(FNMIN$) + VAL(FNSEC$)/
   60:OLDHR = VAL(FNHR$) MOD 12 + VAL(FNMIN$)/60
3040 WHILE OLDSEC = VAL(FNSEC$): WEND 'Wait for next second
3050 SEC = VAL(FNSEC$): MIN = VAL(FNMIN$) + VAL(FNSEC$)/60: HR
   = VAL(FNHR$) MOD 12 + VAL(FNMIN$)/60
3060 ' erase old hands, draw new ones
3070 LINE (XC,YC) - (XC + (180 * FNS(6 * OLDSEC)),YC - 130 * FNC(6
   * OLDSEC)),BC
3080 LINE (XC,YC) - (XC + (180 * FNS(6 * SEC)),YC - 130 * FNC(6 *
   SEC)),RH
3090 LINE (XC,YC) - (XC + (172 * FNS(6 * OLDMIN)),YC - 126 * FNC(6
   * OLDMIN)),BC
3100 LINE (XC,YC) - (XC + (172 * FNS(6 * MIN)),YC - 126 * FNC(6 *
   MIN)),BH
3110 LINE (XC,YC) - (XC + (154 * FNS(30 * OLDHR)),YC - 112 * FNC(30
   * OLDHR)),BC
3120 LINE (XC,YC) - (XC + (154 * FNS(30 * HR)),YC - 112 * FNC(30 *
   HR)),BH
3130 FOR A = 1 TO 4: CIRCLE (XC,YC),A: NEXT
3199 RETURN
```

**You can use this Pink Noise Source as an aid to calibrating the Sound Level Meter described last month. It can also be used as a general purpose signal for setting the balance between loudspeakers in a multichannel (2, 4 or more channels) system and for PA adjustments.**

By JOHN CLARKE

While noise is usually considered a nuisance, it can be useful in some cases. In audio applications it provides us with a signal which covers the entire audible spectrum. This means that there is every conceivable frequency from 20Hz up to 20kHz, all in the one signal.

Armed with this type of signal we can obtain frequency response measurements and a wideband sound level output for loudspeakers. Also it provides a standard sound for subjective listening tests. With an analyser and equaliser we can also adjust the frequency levels from a loudspeaker in a particular room so that it provides a flat response across the audible spectrum.

All of these measurements assume that the noise source has a flat frequency response or an equal energy per octave. This is called "pink" noise. The energy from 20Hz to 40Hz must be the same as that from 10kHz to 20kHz even though there is only a

BUILD THIS

# Pink Noise Source

## For sound level meter calibration & signal balancing

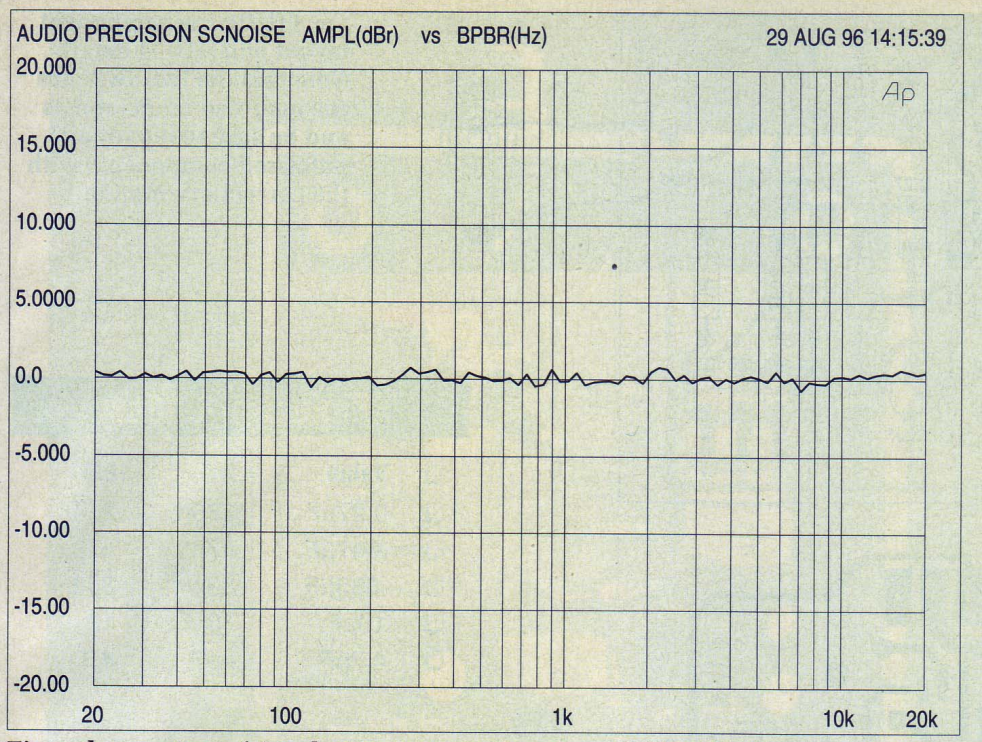



**Fig.1: the spectrum (signal output versus frequency) of the Pink Noise Source. Since the noise source is random, a second response test would no doubt reveal a slightly different result, with perhaps dips in response where slight peaks are shown and vice versa.**

20Hz difference in frequency for the lowest octave and a 10kHz range for the upper octave. Fig.1 shows the spectrum (ie, signal output versus frequency) of the Pink Noise Source featured in this article.

By contrast, the noise from electronic circuits is "white". It has a 3dB rise in output per octave of frequency since it has equal energy per constant bandwidth. So the octave band from 20Hz to 10.02kHz will have the same energy level as the octave between 10kHz and 20kHz.

## Rose-coloured filter

To convert white noise to pink noise we need a filter which has a 3dB/octave or 10dB/decade rolloff. This is a little tricky since a normal single pole low pass filter will roll off at 6dB/octave (or 20dB per decade). A "pink" filter is achieved by rolling the signal off in four discrete steps, introducing further filtering as the frequency rises.

Fig.2 shows the pink noise circuit. It uses a transistor noise source, two op amps for amplification and some passive filtering.

An NPN transistor, Q1, is connected for reverse breakdown between the emitter and base, with current limiting provided by the 180kΩ resistor from base to ground. This provides a good white noise source but it only produces a low signal level.

Op amp IC1a amplifies this noise by a factor of 101. IC1a is AC-coupled and biased to the 4.5V half supply rail to provide a symmetrical swing at its output, pin 1. The 0.27µF input capacitor and bias resistor roll off the response below 0.6Hz. Similarly, the 2.2kΩ resistor and 100µF capacitor in the feedback path at pin 2 roll off response below 0.7Hz. High frequency rolloff above 153kHz is provided by the 4.7pF capacitor across the 220kΩ resistor.

Following pin 1 of IC1a is a passive RC filter to roll off the frequency response at 3dB per octave. This filter is

## Main Features

- Pink noise signal output
- Battery operated
- 0dB and -60dB levels
- Power-on LED

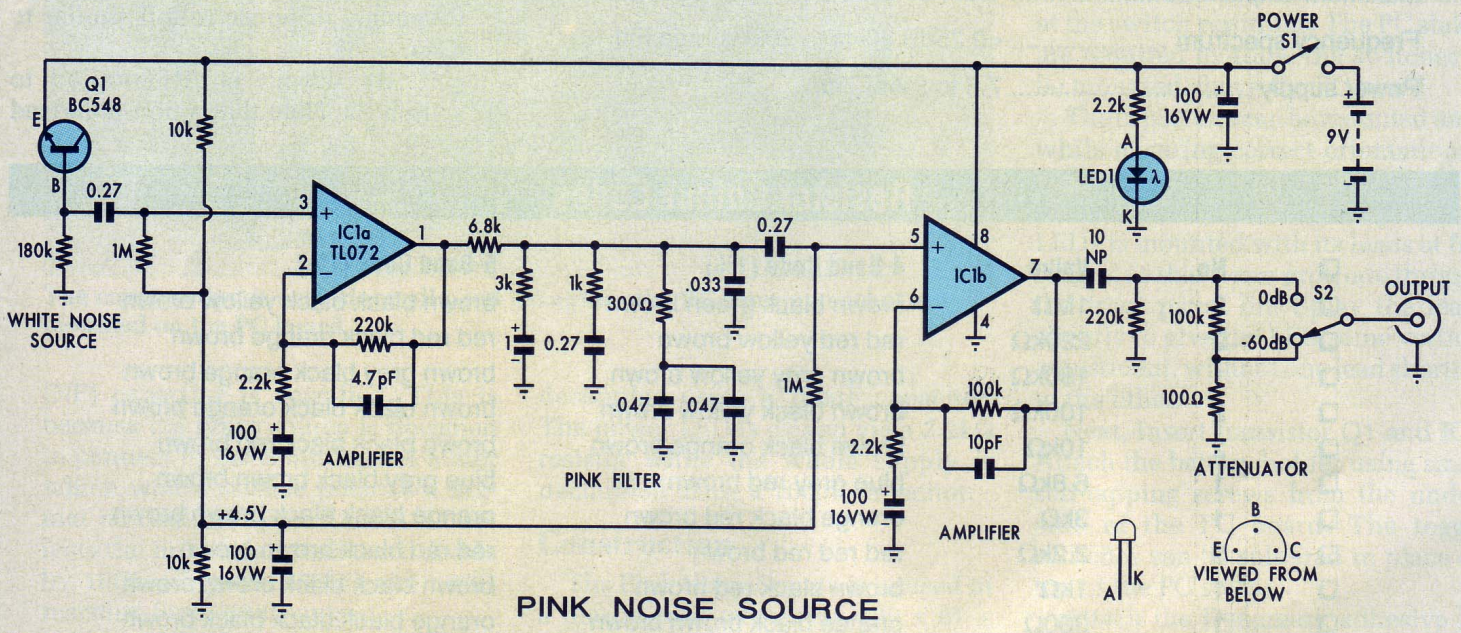



**Fig.2: the pink noise circuit uses a transistor noise source, two op amps for amplification and some passive filtering.**

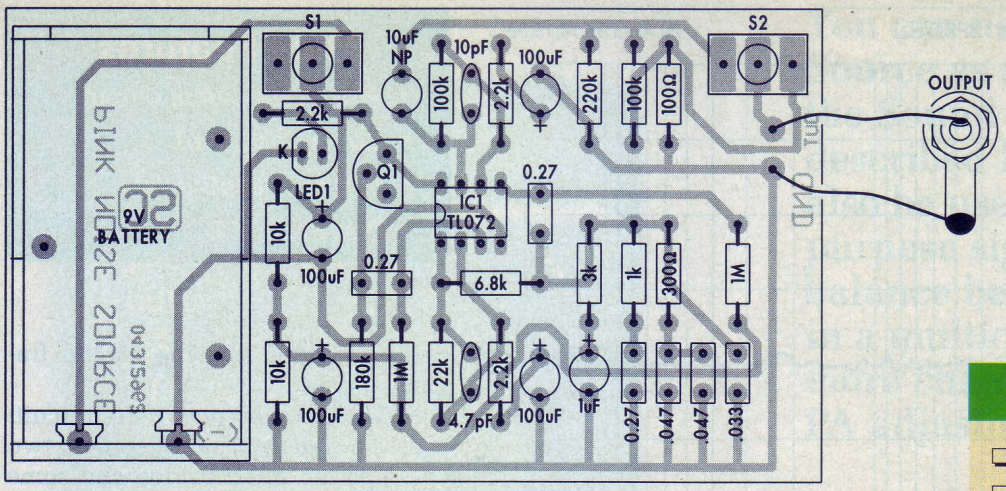



Fig.3 (left): the component layout and wiring details. Note that the two switches are mounted on PC stakes and be sure to mount all polarised components with the correct orientation.

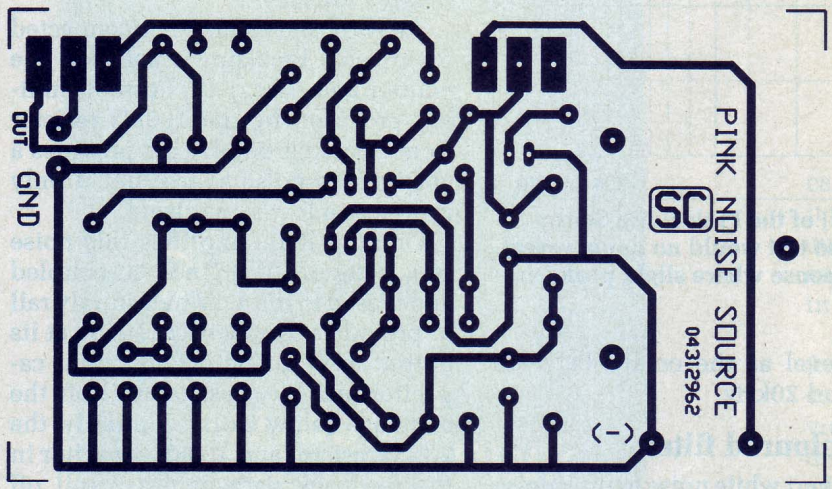



Fig.4: check your etched PC board against this full-size artwork before installing any of the parts.

## Capacitor Codes

| Value | IEC | EIA |
|---|---|---|
| 0.27µF | 270n | 274 |
| .047µF | 47n | 473 |
| .033µF | 33n | 333 |
| 10pF | 10p | 10 |
| 4.7pF | 4p7 | 4.7 |

## Performance

| | |
|---|---|
| Output levels | 60mV RMS at 0dB; 60µV at -60dB |
| Maximum output load | 1kΩ (for <1dB error in 60dB attenuator) |
| Frequency spectrum | <0.25dB 20Hz to 20kHz (see Fig.1) |
| Power supply | 7.6 to 9V at 7mA |

accurate to ±0.25dB from 10Hz to 40kHz, assuming the use of close tolerance capacitors. The spectrum response shown in Fig.1 is that of the prototype using normal 10% tolerance capacitors.

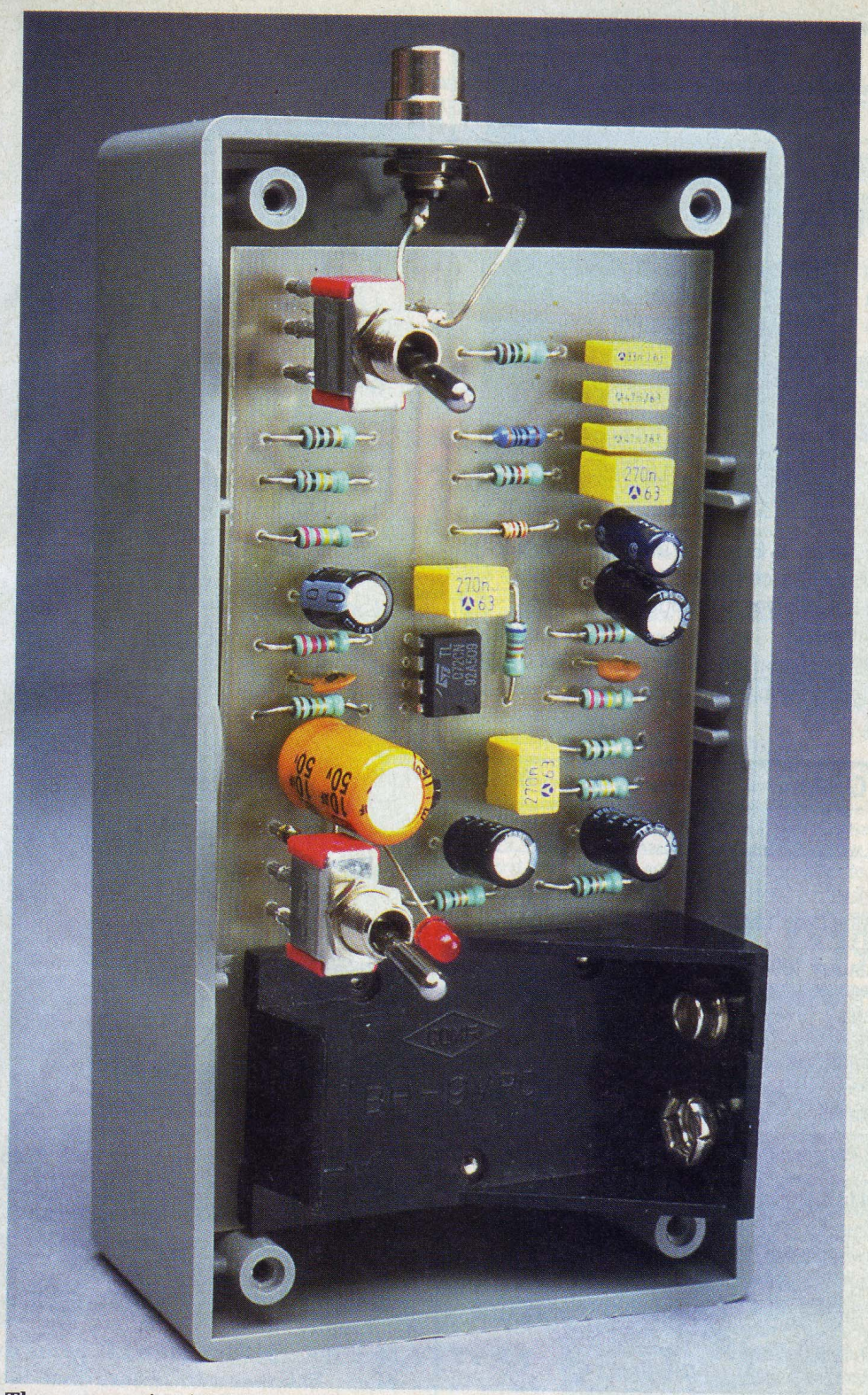
Note that the signal levels shown in Fig.1 are the actual levels at the instant the measurement was taken. Since the noise source is random, a second response test would no doubt reveal a slightly different result, with perhaps dips in response where slight peaks are shown and vice versa.

The pink noise output is AC-coupled into op amp IC1b which has a gain of 46. This has a low and high frequency response rolloff similar to IC1a.

IC1b's output is AC-coupled to switch S2. Note that a non-polarised

## Resistor Colour Codes

| No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|
| 2 | 1MΩ | brown black green brown | brown black black yellow brown |
| 2 | 220kΩ | red red yellow brown | red red black orange brown |
| 1 | 180kΩ | brown grey yellow brown | brown grey black orange brown |
| 2 | 100kΩ | brown black yellow brown | brown black black orange brown |
| 2 | 10kΩ | brown black orange brown | brown black black red brown |
| 1 | 6.8kΩ | blue grey red brown | blue grey black brown brown |
| 1 | 3kΩ | orange black red brown | orange black black brown brown |
| 3 | 2.2kΩ | red red red brown | red red black brown brown |
| 1 | 1kΩ | brown black red brown | brown black black brown brown |
| 1 | 300Ω | orange black brown brown | orange black black black brown |
| 1 | 100Ω | brown black brown brown | brown black black black brown |



The construction is easy since all parts except for the RCA output socket are mounted on the PC board.

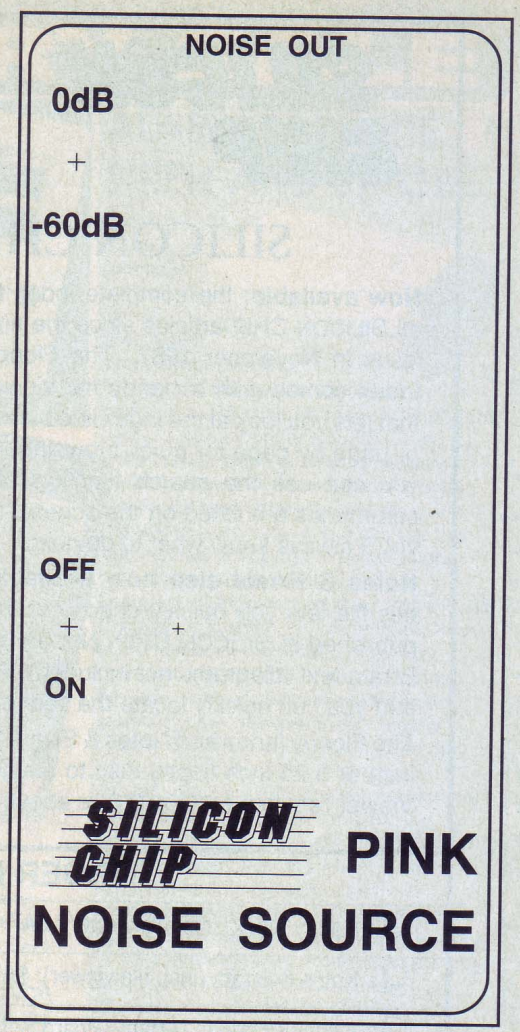



**Fig.5: this is an actual size artwork for the front panel.**

(NP) capacitor is specified. This is because the noise source is designed to connect to the Sound Level Meter which would reverse polarise a normal electrolytic type. Switch S2 selects the full output (0dB) or a divide by 1000 using the 100kΩ and 100Ω resistors for a -60dB output.

The 4.5V half supply is derived from a 10kΩ resistive divider which is decoupled using a 100µF capacitor. The power LED is driven via a 2.2kΩ resistor while the whole supply is decoupled using a 100µF capacitor.

## Construction

The Pink Noise Source is housed in a plastic case measuring 130 x 67 x 41mm. The circuitry fits onto a PC board coded 04312962 and measuring 104 x 60mm. The wiring details are shown in Fig.3.

Begin construction by checking the PC board for defects. This done, install the resistors and install PC stakes at the switch positions. The PC stakes are required to allow the switches to be mounted above the PC board.

The capacitors can be mounted next, while ensuring correct orientation of the electrolytics. The 10µF NP capacitor can be mounted either way around. LED1 is mounted with its leads at full length, so that it can protrude through the front panel lid. Splay the leads slightly to give the LED some vertical adjustment, without one lead shorting to the other.

Next, insert transistor Q1 and IC1. Attach the battery holder using small self-tapping screws from the underside of the PC board. The toggle switches can be soldered in place on top of the PC stakes.

Attach the Dynamark adhesive label on the lid of the case and drill out the holes for the switches, LED bezel

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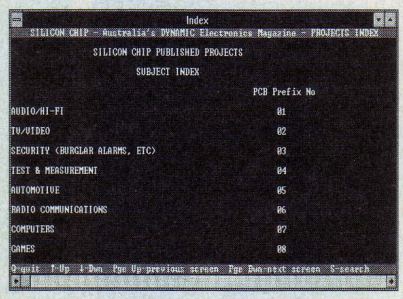


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## PARTS LIST

1 plastic case, 130 x 67 x 41mm
1 PC board, code 04312962, 104 x 60mm
1 self-adhesive label, 61 x 123mm
2 SPDT toggle switches (S1,S2)
1 panel mount RCA socket
1 9V battery holder
1 9V battery
1 3mm LED bezel
8 PC stakes
3 small self-tappers for the battery holder

**Semiconductors**
1 TL072 dual op amp (IC1)
1 BC548 PNP transistor (Q1)
1 3mm red LED (LED1)

**Capacitors**
4 100µF 16VW PC electrolytic
1 10µF NP PC electrolytic
1 1µF 16VW PC electrolytic
3 0.27µF MKT polyester
2 .047µF MKT polyester
1 .033µF MKT polyester
1 10pF ceramic
1 4.7pF ceramic

**Resistors** (0.25W 1%)

| | |
|---|---|
| 2 1MΩ | 1 3kΩ |
| 2 220kΩ | 3 2.2kΩ |
| 1 180kΩ | 1 1kΩ |
| 2 100kΩ | 1 300Ω |
| 2 10kΩ | 1 100Ω |
| 1 6.8kΩ | |

and corner mounting locations. Also drill a hole in the end of the case for the RCA socket. Attach the socket and clip the PC board in place against the integral side pillars of the box. Wire up the RCA socket as shown in Fig.3.

Finally, insert the battery and attach the lid with the LED bezel in place. Take care to ensure that the LED protrudes through the bezel before tightening the case screws.

## Testing

You can test the unit by connecting the output to an amplifier and speaker. Apply power and listen to the noise which should occur after several seconds. Alternatively, look at the signal on an oscilloscope. A multimeter should give an AC reading of around 60mV on the 0dB range and 0V on the -60dB position of S2. **SC**

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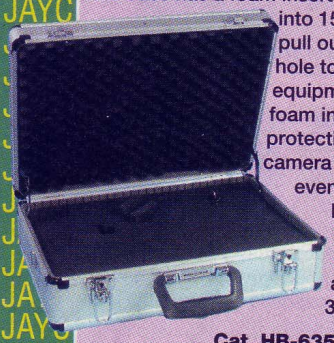
# JAYCAR JANUARY SALE

## ALUMINIUM CASE WITH FOAM

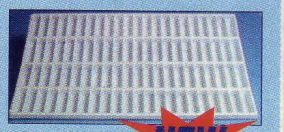
NEW

This case has a foam insert which has been perforated into 15mm square holes. Simply pull out the squares and form a hole to put your valuables equipment in. The lid also has a foam insert for complete protection. Ideal for carrying your camera or video equipment, or even wine and glasses! Case is lockable and two keys are supplied. Case is the same size as our economy attache case. Size 450(W) x 320(H) x 125mm(D).



**Cat. HB-6356** **$69.50**

## RESISTOR STORAGE TRAY



NEW

Brand new model for 1997. Now with 88 compartments! (The old model had 36). Enough to hold one of our RR-1697 resistor packs (10 of every 1/4w from 1Ω to 10m). Each compartment will hold 40 resistors if they are not bandoleered. If bandoleered, they form a friction fit with the ends of the cell and will not fall out. Now with lid. Also included is a clear slide on lid, that keeps all the goodies in their place. Size 420mm(L) x 275mm(W) x 13mm(D). Compartmenr size 60mm(L) x 16mm(W) x 8mm(D). An excellent low cost way to store resistors, capacitors, transistors, diodes, nuts, bolts, buttons etc.,etc.,etc.

**Cat. HB-6342** **Only $11.95**

## SURROUND SOUND SPEAKERS

NEW

These speakers are ideal for Dolby surround sound systems, as well as wall speakers for general stereos! They incorporate a unique swivel bracket that allows them to be pointed directly down to the listening area. Speakers inside are a 4" woofer with large 5.3oz. magnet and 1" dome tweeter. White colour to suit most houses. Specifications •Power handling-25 WRMS •Frequency response-20Hz-20kHZ •Impedance-6ohms •Woofer-4" 5.3oz magnet •Tweeter-1" dome •Colour-White •Size-220mm(W) x 240mm(H) x 130mm(D).

**Cat. CS-2520** **$99.00 Pair**

## 1.3AH SUB "C" BATTERY

Sub C batteries are commonly used in RC racing cars & power drill battery packs. Supplied with solder tabs.

**Cat. SB-2456** **Were $6.95**

**Now $4.95 ea** **Save $2**

## NEW MICROTAC BATTERIES

SLIM NI-MH 900 MAH

Only 12mm thick **Cat. SB-2569**

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JUMBO 2100 MAH NI-MH

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NEW

## FREECALL FOR PHONE ORDERS 1800 022 888

## DIGITAL HYGROMETER

Two displays, one reads the temperature, the other relative humidity. It also records the minimum and maximum temperature and humidity. See 96 catalogue, page 171 for full details.

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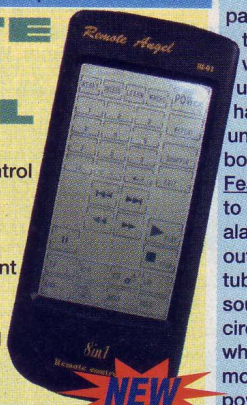
**Jan $35** **Save $14.95**

## ULTIMATE REMOTE CONTROL



NEW

This must be the ultimate remote control! It is a learning remote control and will operate up to 8 pieces of equipment. It is quite unique in as much as it has a different LCD display for each piece of equipment its controlling. For example, the VCR mode displays the typical VCR functions and when switched to the TV, the TV controls appear on the screen. And, if you don't want all the functions on a display, you can simply delete what tou don't want. There are 28 programmable visual keys for each individual component. You can teach any command key , any function in each of the 8 devices. The 8 functions are:- TV, VCR, CD, LD, AMP, Tuner/Taper, Sel1, Sel 2. Sel 1 and 2 are spares - so if you have two VCR's for example you simply programme sel 2 for the 2nd VCR. An amazing piece of equipment, that is well worth the asking price.

**Cat. AR-1720** **Only $179.50**

## ALARM SATELLITE SIREN AND STROBE

NEW

This is a micro-processor controlled alarm device with siren. strobe, back up battery and tamper switch combined in one unit. A unit such as this is an important part of a home burglar alarm because, if the burglar alarm or siren is tampered with or disabled, this module will sound under its' own battery power, so you still have some protection. You can use this unit instead of buying the usual - metal box, strobe and speaker.

Features: •If triggered, strobe can be wired to continue flashing, so you instantly know alarm has been triggered. •High siren output at 116 dB / 1M. •Double strobe tubes for extra visibility •Selectable siren sounding time. •Rechargeable battery circuit. •Double tamper circuit - detects when wire is cut, or box is opened or moved. •Built in LEDS advise you of panel power failure, as well as tampers and battery charge mode •Easy installation. •Polycarbonate housing which is fire-resistant, impact resistant and heat-resistant. Specifications: •Power supply - 12V DC from alarm panel •Back up battery - 9.6V 300mA NiMH •Current drain standby 20mA max.,operating 300mA max. •Tamper contact - NC relay contact 1A at 24V •Size - 206(H) x 146(W) x 65(D)mm. •Strobe colour - Blue

**Cat. LA-5305** **$89.50**

## Pre-Programmed Remote Control with Clock

NEW

If your TV or VCR remote control has died, then replace it with this instead of paying $80 plus for the exact one from the manufacturers spare parts department. This remote is pre-programmed and will work on most TV's and VCR's. To programme, simply find your brand of TV or VCR from the list of codes supplied and enter it in. If this fails, there is an "auto search" function in which the remote checks all its preprogrammed codes to find the one that will operate your equipment. Includes an LCD display which displays either the time/date or the 3 digit brand programmed code. Also includes "punch through" which allows you to operate the TV volume if in VCR mode. An easy to use remote control, at an amazing "direct import' low price!

LCD DISPLAY
•Clock •Date
•Code

**Cat. AR-1700** **ONLY $29.95**

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| 9 Volt 100mA | SB-2458 | $17.95 | $13.95 | $4.00 |
| AA 550mAH | SB-2452 | $2.50 | $1.75 | $0.75 |
| AA 720mAH | SB-2450 | $3.50 | $2.50 | $1.00 |
| AA 720mAH with solder tags | SB-2451 | $3.75 | $2.50 | $1.25 |
| AAA 180mAH | SB-2454 | $6.95 pkt 2 | $4.95 pkt 2 | $2.00 |

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# UNBELIEVABLE SURPLUS SPEAKER DEALS

We have made a massive purchase of some discontinued speakers from Etone. The speakers are NOVIK brand and are made in Brazil. NOVIK have been around for some time, we even used to sell them some years ago. Ideal replacement speakers. Save up to 50%. Limited quantities.

## 12" WOOFER

Power handling 40WRMS Frequency response 30Hz - 3.5kHz. Paper cone, plastic front surround. Speaker weight 1.6Kg.

**Cat. CW-2124** **Only $29.95ea**

## 10" WOOFER

Power handling 40WRMS Frequency response 35Hz - 4.0Khz. Paper cone, plastic front surround. Speaker weight 1286gr.

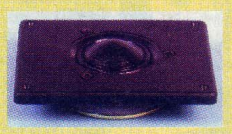
**Cat. CW-2120** **Only $24.95ea**

## 5" MIDRANGE

Power handling 120WRMS system power. Suggested crossover points - 800Hz and 5Khz. Clear poly-propylene cone. Speaker weight 590gr.

**Cat. CM-2070** **$14.95**

## DOME MIDRANGE



Power handling 150WRMS system power. Suggested crossover points 500Hz & top crossover point between 5Khz and 12Khz. Speaker weight 810g. Size 130W x 114Hmm front. Cutout about 90mm dia. 1.5" (38mm) dome. **Cat. CM-2074** **$24.95**

## 6" 8Ω TWINCONE

Ideal low cost replacement speaker. Has a twincone and cardboard cone. power handling is around 6watts. Diagonal mounting holes 155mm. Weight 353gr.

**Cat. AS-3013** **$7.95**

## 8" TWINCONE PA SPEAKER

This twincone 8" speaker is ideal for PA. It is very similar to our CE-2325 model, except that it does not have mounting holes for a line transformer. Power handling is 10WRMS. Frequency response is about 100Hz to 17,000HZ. Weight 430gr.

**Cat. CE-2326** **$12.95**

## ROUND CONE TWEETER

Power handling - about 50WRMS system. Frequency range 2K - 16Khz. Suggested crossover point is about 3Khz. Overall diameter 85mm. Cutout size - min.55mm. Weight 108gr.

**Cat. CT-2001** **$9.95**

## SQUARE CONE TWEETER

Power handling - about 50WRMS system. Frequency range 2K - 16Khz. Suggested x'over point is about 3Khz. Size - 57 x 57mm. Cutout size 55mm. Weight 93gr.

**Cat. CT-2002** **$7.95**

## PIEZO TWEETER

Power handling 120WRMS, no crossover required. Front panel size 135(W) x 65(H)mm.

**Cat. CT-1915** **$8.95**

## Communications Speaker With Noise Filter

Impedance is 8 ohms, power handling is 8 watts, maximum 15 watts and incorporates a noise filter with on/off switch. Supplied with 2 metres of cable to a 3.5mm mono plug. Size - 100(W) x 100(H) x 62(D)mm.

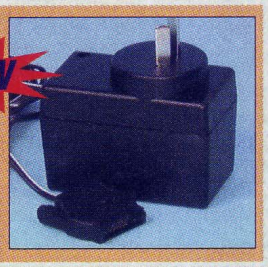
Limited quantity. Cat. AS-3190

***Was $24.95 Save $10***

***Now $14.95***

## 6V NICAD CHARGER

NEW



ARLEC brand 6.6V 110mA Nicad charger. These were designed to charge a cellular telephone battery. The lead terminates to a strange plug which needs to be removed. Ideal for charging any 6V Nicad or 5 x 1.2V in series in a battery holder, or Nicad packs etc., etc.

**Limited quantity available** **Cat. MB-3506**

**Only $7.50 or 10 for $50**

## SUPER DRILL SET

Fantastic new drill with precision quick-change chuck. Perfect for drilling, polishing, engraving, routing, shaping, sanding and milling. Supplied with the following accessories: •5 collets - Dia. 0.5, 1.0, 1.5, 2.4 and 3.0mm. •4 different shaped grindstones with abour. •1 super thin grinding wheel. •5 sized drill bits. •240V mains plug pack.

**Cat. TD-2460** **$59.95**

## SAVE $20 ON CAR AMP 24WRMS X 4 CHANNELS

Features - Hi-Low level input, auto on/off with head unit, adjustable gain control. See 1996 catalogue, page 67. **Cat. AA-0410**

**Was $119.50 Save $20**

**Jan $99.50**

## BREADBOARD REDUCED !!!

We've negotiated better pricing and passing the savings on! See 1996 catalogue page 92 for full details.

NEW

| DESCRIPTION | CAT. | Was | Now | Save |
|---|---|---|---|---|
| Distribution Strip - 100 hole | PB-8810 | $4.25 | $3.75 | $0.50 |
| Terminal Strip - 630 hole | PB-8812 | $13.50 | $9.95 | $3.55 |
| 830 Point Breadboard | PB-8814 | $18.95 | $14.95 | $4.00 |
| 1660 Point Breadboard/Plate | PB-8816 | $44.95 | $29.95 | $15.00 |
| 2390 Point Breadboard/Plate | PB-8818 | $56.95 | $42.95 | $14.00 |
| 3220 Point Breadboard/Plate | PB-8820 | $75.00 | $54.95 | $20.05 |

## ELECTRONIC WATCHDOG SELLOUT

SAVE $30

We've made a scoop purchase, which normally sells for $199. If you are aged or live on your own, owning a dog can offer you wonderful peace of mind, especially at night from the risk of intruders. The electronic watchdog incorporates a microwave motion sensor which activates when it detects movement and then it starts barking. It barks for 5 seconds each time it is triggered and barks continually if there is constant movement. The Watchdog is best mounted about 1.5mt high. Its surveillance distance is 6-8 metres. Because it's microwave, it will detect through any obstacle so it can safely look through a window, down a driveway, across a verandah, etc. The sound is very authentic and would easily scare the wits out of an intruder. The unit is housed in a metal box with a handle on the top. It operates from 240V through a plugpack (supplied) and has a volume control and a range control. Call into any store for a demo.

Cat. LA-5280 ***Was $129.50***

***JANUARY $99.50***

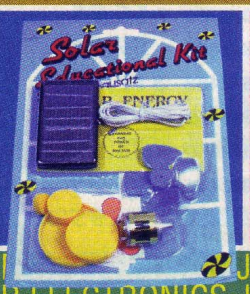
## SOLAR EDUCATION KIT

Great for kids. Experiment with solar energy. See 96 catalogue, page 168. **Cat. KJ-6690**

***Was $10.95***

***Jan $8.95***

***Save $2.00***




## SAVE $20 ON LASER POINTER

For pointing out objects that are out of reach.

**Cat. ST-3100** **96 Cat. Price $89.50**

**Now $69.50 Save $20.00**

## JAYCAR WHOLESALE (02) 9743-5222

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JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRON

# POCKET DMM'S REDUCED

## MANUAL

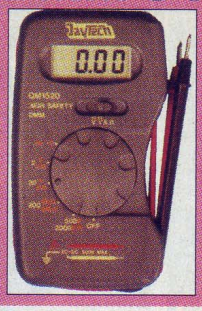
3.5 digit, wrap around leads, small size, one hand operation, continuity buzzer, diode test.

Cat. QM-1520

**Was $34.95**

**Now $26.95**

**Save $8.00**



## AUTORANGE

3.75 digit, data hold 3999 count, wrap around leads, small size one hand operation, continuity buzzer, diode test.

Cat. QM-1540

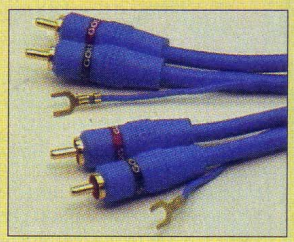
**Was $49.95**

**Now $39.95**

**Save $10.00**

# OFC PRO SERIES RCA LEADS

Top quality OFC Pro Series RCA audio leads with gold plugs and central lead wire for remote switching of car amps, or for grounding on Hi Fi home systems. Cable is figure 8 OFC blue colour with an OD of 6mm each side. Plugs are gold plated and mounted to the cable. Each lead has two RCA plugs on each end.



Specifications. •Material: Oxygen free copper •Centre conductor: 19 x 0.18 •Switch wire: 19 x 0.18 •Shielding : 112 x 0.12 •Shield type: Spiral •Outside diameter: 6 x 12mm •Foam PE: 3.7mm •Colour: Dark blue

| | | |
|---|---|---|
| 1.5 METRES | Cat. WA-1070 | $11.95 |
| 2.5 METRES | Cat. WA-1072 | $14.95 |
| 5.0 METRES | Cat. WA-1076 | $19.95 |

# 30 PIECE ENGINEER'S DRIVER SET

Kit inc: • 5 slotted bits 0-1, 3-4, 5-6, 8-10, 12 • 5 hex bits 3/32", 5/64", 7/64", 1/8", 9/64" • 4 Philips bits No 0, 1, 2 & 3 • 4 square recess bits No 0, 1, 2 & 3 • 6 Torx bits T10, T20, T25, T30, T40 • 2 Pozidrive bits No 1 & 2 • 1 x 1/4" drive socket adaptor • 1 x 1/4" drive hex bit holder •Sealable tough plastic case. Cat. TD-2000 *Was $12.95*

***Jan $9.95*** *Save $3.00*

# COLOURED DISKS

Pack of 25 x 3.5" high density IBM formulated disks in 5 different colours. (5 x blue, 5 x pink, 5 x yellow, 5 x white and 5 x green). 100% error free.

**PACK OF 25**

Cat. XC-4742

**Only $16.95**

# 500W 12-230V INVERTER

See our 1996 catalogue, Page 75 for full details & specifications. Cat. MI-5050

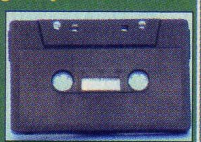
**Was $419**

**Save $120**

**SELLOUT PRICE $299**

# CASSETTE HEAD CLEANER TAPE

Cassette player heads need cleaning regularly. Grab a couple of these and never have to worry about head cleaners again. Tape supplied in a plastic bag. No case supplied.



Cat. AR-1460

Normally around $3.95ea

**Only 2 for $1**

# 6.5mm PATCH CORDS

Set of 5 colour coded patch leads. Stereo 6.5mm plug on each end (O.K. for mono). Length 200mm. Cable is shielded.

Cat. WA-1054

**Retail $14.95 Pkt 5**

**Now $6.95 Pkt 5**

**BUY 10 LESS 10%**

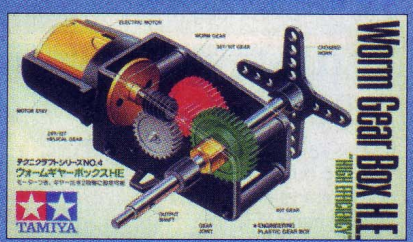
# 3 PC. COUNTERSINK BIT SET

The easy way to countersink. Three bits supplied for use with your drill. Bit sizes are 12, 16, and 19mm diameter.

Cat. TD-2028 **$6.95**

# WORM DRIVE GEARBOX

**High Efficiency!**




216: or 336:1 reduction ratio. It's efficient and it cannot be "driven" by the load. Made in Japan by Tamiya. Like our YG-2720 Planetary gearbox, this set comes complete with a genuine Mabuchi RC-260 3 - 4.5V motor, colour coded gearset, (216:1 or 336:1 reduction ratio), 4mm hardened steel output shaft (which could be an axle - it is symmetrical with threaded [3mm] ends and holes for spring pins!), all nuts and screws, including grub screw with allen wrench, lubricating grease etc. The gearbox casing is precision moulded in high grade ABS engineering plastic. There is even a spare passive axle and axle carrier!! In addition to this you get four drive cranks and complete exploded - view assembly instructions. Measures 76mm long (inc. motor) Gearbox body is 30mm wide and 31mm high. 216:1 3,400 g/cm ; 336:1 5,400 g/cm

Cat. YG-2718

**Was $37.95 Jan. $29.95 Save $8.00**

# Jaytech FOUR SECTOR ALARM DEAL

Save a fortune by buying our ALARM DEAL NO 1 using the Jaytech 4500 panel. Includes all the components needed to give you a quality basic home alarm system. All you need is a bit of labour and you have a reliable affordable alarm that offers you peace of mind.

| INCLUDES: | NORMAL PRICE |
|---|---|
| 1 x 4 sector Jaytech panel | $109.50 |
| 2 x Jaytech pulse count PIRs | $59.90 |
| 1 x mains power supply | $21.50 |
| 2 x reed/magnet switches | $11.50 |
| 1 x siren horn | $25.95 |
| 2 x deterrent stickers | $4.00 |

**PROTECT YOUR HOME FOR UNDER $200**

| | |
|---|---|
| 50 m of 4 core alarm cable | $28.00 |
| **NORMALLY PAY** | **$260.35** |
| Cat. LA-5450 | **$199** |

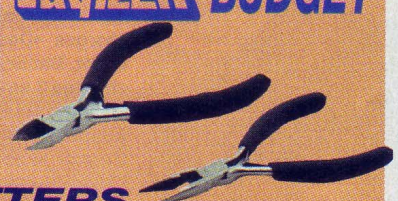
# FLEXIBLE SOCKET COMBINATION WRENCH SET

Set of 6 double ended wrenches with pivoting end sockets. These allow easier access when working in tight places. Tools are made from tough tempered drop forged steel and are triple chrome plated. Supplied in a vinyl carry pouch.

Sizes are: 8x9, 10x11, 12x13, 14x15, 16x17 and 18x19mm

Cat. TD-2110 **Only $29.95**

# Jaytech BUDGET



# CUTTERS

110MM CUTTING NIPPERS

Cat. TH-1882

**Was $9.95**

**Jan. $7.95**

**Save $2.00**

# PLIERS

125MM WITH SERRATED JAWS.

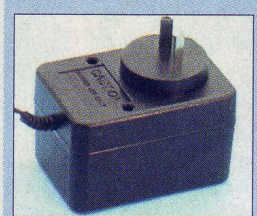
Cat. TH-1884

**Was $9.95**

**Jan. $7.95**

**Save $2.00**

# SEALED LEAD ACID BATTERY CHARGERS



Fully automatic. They switch to trickle charge automatically when battery is charged. LED indicator has different flash rates to adivse when battery is charged. These deliver 100% full charge batteries.

| 6V CHARGER 500mA | 12V CHARGER 350mA |
|---|---|
| Cat. MB-3516 | Cat. MB-3517 |
| $29.95 | $29.95 |

# 5 PIECE TORX SCREWDRIVER SET

Easy to use colour coded torx screwdrivers in a plastic case. Each screwdriver has a swivel head for easy use. Blade length is 20mm and torx sizes are T6, T7, T8, T9 & T10.

Cat. TD-2070 **$7.95**

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**MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888**

## MULTIFUNCTION ELECTRICAL AND ELECTRONIC TESTER

It does the following:•AC voltage test - contact method from 70-250VAC or non contact from 70-10,000VAC •DC voltage test - up to 250VDC •Continuity test •Polarity check - 1.2 to 36VDC •Microwave oven leak detector check •Wrong mains connection check •Capacitor check •Diode check •Transistor check •Ignition check •Globe / relay / fuse / speaker / speaker check •TV / monitor static radiation check **Cat. TD-2050**

***Was$9.95 Jan$7.50 Save$2.45***

## 1" HIGH FREQUENCY COMPRESSION DRIVER SELLOUT

This driver exhibits a wide, smooth frequency response with low distortion and SPL of 102dB 1W/1M. Impedence 16Ω, power handling 35WRMS sine wave above 1500Hz. See 96 catalogue, page 50 for full details. Limited quantity available.

**Cat. CT-1950 Was $119 Now $89 Save $30**

## HORN FOR COMPRESSION DRIVER

120 X 90° exponential horn. Made from ABS. Size 318(W) x 198(H) x 211(D) mm. See 96 catalogue, page 50 for full details. Limited quantity available.

**Cat. CT-1952**

**Was $99.00 Save $24.00**

**January $75.00**

**ORDER NOW**

SAVE

## VIFA D19 TWEETER

Save a massive $10 in January. See 96 catalogue, page 38 for full details. **Cat. CT-2019**

**Was $39.50**

**Jan Only $29.50 Save $10**

## 15" 200 WATT PROFESSIONAL PA DRIVER

Suitable for high power PA applications. Power handling 200WRMS. Will work OK in both sealed and vented boxes. See 96 catalogue, page 49 for full details. **Cat. CG-2388**

**Was $239**

**Now $199 Save $40**

**BUY 10 LESS 10%**

## SEMI CONDUCTOR PACK

**BRAND NEW PACK** full of brand new semiconductors, diodes etc. Min. quantity in bags 100 pcs.

**Cat. ZP-8990**

**Only $10**

## JAYCAR PULSE COUNT PIR

See 96 catalogue, page 151 for full details.

**Cat. LA-5025**

**Cat. Price $29.95**

**Jan. Price $25ea. or 5 for $110.00**

## MICROWAVE OVEN LEAK DETECTOR

Keep an eye on your microwave oven for harmful leaks.

**Cat. QM-7260**

**Was $13.95 Save $5**

**Jan $8.95**

## NICAD BUTTON CELL

Make your own Nicad packs. Used in many cordless telephone battery packs. Capacity - 280mAh. Voltage 1.2V. Size 25(Dia.) x 8.8(H)mm. See 96 catalogue, page 72 for full details.

**Cat. SB-2470 Was $2.95**

**Now $1.95 Save $1**

## DIGITAL TYRE PRESSURE GAUGE

Reads digitally in PSI **Cat. QM-7235 Was $19.95 Jan $15.00 Save $4.95**

## CEILING MOUNT PIR

This PIR will mount on the ceiling and features pulse count operation which helps eliminate false alarms.

**Cat. LA-5020**

**Cat. Price $49.95**

**Jan $34.95 Save $15.00**

## BACKSHELL BARGAINS

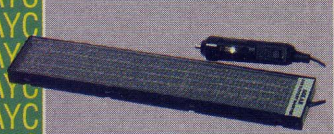
These are rightangle and metal.

| DESCRIPTION | CAT. NO. | WAS | NOW | 10 PLUS |
|---|---|---|---|---|
| 9 pin | PM-0814 | $3.95 | $2.50 | $2.00 |
| 15 pin | PM-0834 | $4.25 | $2.70 | $2.20 |
| 25 pin | PM-0849 | $4.50 | $3.00 | $2.60 |

Very limited qty of 25 pin

**ALL JAYCAR STORES ARE NOW ON EFTPOS!!!**

## SOLAR CAR BATTERY BOOSTER



Keep a small charge feeding your battery while you are away, or not using the car. See 96 catalogue, page 74. Limited quantity available.

**Cat. MB-3503**

**Was $29.95**

**Jan $22.95**

**Save $7 This Month**

## ADD ULTRASONIC TO YOUR CAR ALARM FOR EXTRA SAFETY

Will connect to any car alarm that has a spare input wire. Will pick up a thief who breaks a window and crawls in, therefore by passing the voltage drop caused by the door opening/interior light. See 96 catalogue, page 158.**Cat. LA-8906**

**Was $64.95 Save $20**

**January $44.95**

## 12V CELLULAR PHONE / VIDEO BATTERY DISCHARGER, DEEP CONDITIONER & FAST CHARGER

**Suitable for Ni-cad & Ni-mh cells.**

Features:- •When battery is charged, switches to trickle charge •Discharges then automatically fast charges •Deep conditioning of Ni-cads with memory effect. Battery is automatically discharged and charged 3 times •Self test mode •Temperature sensor •Powered by 12V. For 240V use 1A mains adaptor. Cat. MP-3015 $22.95. Adaptors required for different batteries.

Charger supplied with Motorola Microtac adaptor.

Other adaptors: All $12.95 each •Motorola 8000/9000/9800 7.2V - Cat. MB3555 •NEC P3/P300 6.0V - Cat. MB3556 •Ericsson 237/337 6.0V - Cat. MB3557 •Oki 700 6.0V - Cat MB3558 •Oki 900 6.0V - Cat. MB3558 •Nokia 2110 6.0V - Cat. MB3559 •Nokia 100/101/121 - Cat. MB3560 Video Camera Battery Adaptors: •Sharp, Hitachi, Sony - Cat. MB3565 •Panasonic, Canon, JVC - Cat. MB3566

**CELLULAR PHONE CHARGER Cat. MB-3550 Was $69.95**

**240V Adaptor $22.95**

**Total $92.90**

**Now Only $69.95 Save $22.95**

**Charger is supplied with cigarette lighter lead, 240V adaptor and Microtac adaptor

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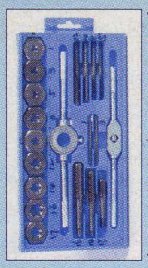
## OFFSET RATCHET SPANNER SET

No more skinned knuckles trying to tighten awkward nuts and bolts. They are easily reversible by touching a tab on each end. They are offset, so the handle is raised, rather than flat, making them easier to use. Five double ended tools supplied, with the following sizes: 5.5, 6.0, 7.0, 8.0, 10.0, 11.0, 12.0, 13.0, 14.0 and 17.0mm

**Cat. TD-2112**

**$24.95**

## TAP AND DIE SET



Tap & dies are used to put a thread either onto round rods, or into a hole. Ideal for tapping into boxes, panels etc, etc. This 21 pce set contains the following sizes: 3,4,5,6,7, 8,10 & 12mm (metric) and 1/8" (imperial) 27 TPI pipe thread. Plus tap handle, die handle & carry case.

**Cat. TD-2114** **$24.95**

## ALARM CHRONOGRAPH CALCULATOR WATCH

This watch includes the following; •Time - hour, minute, second •Date - month, day •12/24 hour mode •Chronograph in 1/100 sec •Alarm •8 digit calculator.

**Cat XC-0265** ***Was $12.95***

***Jan. $7.95 Save $5***

## 10 BAND PORTABLE RADIO

Features AM, FM, LW and SW 5.85mHz - 22.1mHz. See 96 cat. page 178 for full details.

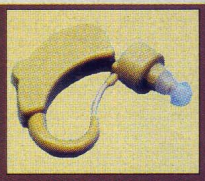
**Cat. AA-2210**

**Was $29.95**

**January $20**

**Save $9.95**

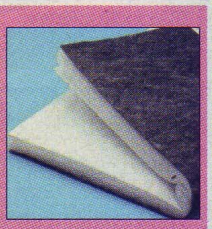
## MAJIC EAR



Majic Ear is an amazing aid to hearing that sits comfortably behind your ear and magnifies sound with superb clarity. Simply use it when you need to, and store it away in its case thats supplied. There is also 3 different earpieces so you can be assured of a perfect fit. There is an adjustable volume control and an on/off switch. Complete with battery and a spare. Don't put up with trouble hearing!!! **Cat. QM-7230**

***Was $19.50 Save $7 Jan $12.50***

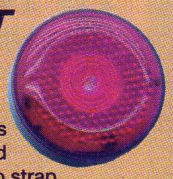
## SPEAKER DAMPENING MATERIAL



Brand new product. The better way to deaden your speaker boxes. White on one side, grey on the other. Ideal if your car subwoofers are on display - you can line them with grey material, instead of the usual white. Supplied in a single pack of one piece which measures 1mtr. x 700mm. 330gsm. New low price.

**Cat. AX-3690** **Only $6.95**

## MINI SAFETY LIGHT



Really small - Only 32mm dia. x 13mm deep. Includes a belt clip and velcro strap. Visible distance over 600 meters.

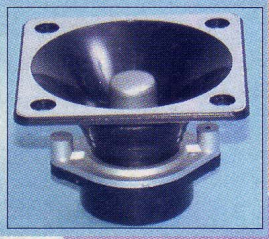
**Cat. ST-3045**

**Was $5.95**

**Jan $3.95**

**Save $2.00**

## ECONOMY PIEZO TWEETER RUN OUT SALE

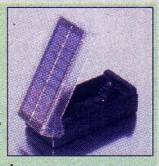


Ideal replacement or add on to existing system for more heights. Power: 75 watts, peak intermittent. Frequency: 3.5K to above 20Khz.

**Cat. CT-1905** **Was $12.50**

**Save $4** **Now $8.50**

## SOLAR BATTERY CHARGER SELLOUT



Will charge 2 pces. of D, C, AA or AAA batteries at a time.

**Cat. MB-3505** **Save $10**

**Cat. Price $24.95** **Jan $14.95**

## RECHARGEABLE MINI TORCH

When you aren't using it, simply put it in the cigarette lighter socket, and the batteries will be fully charged next time you use it.

**Cat. ST-3030** ***Was $11.95 Save $3.00***

***JANUARY $8.95***

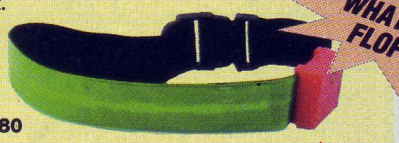
## 12V QUARTZ HALOGEN SPOTLIGHT

1,000,000 candle power. Incorporates tripod stand in the handle.

**Cat. ST-3028** ***Was $29.95***

***January $25 Save $4.95***

## ILLUMINATED SAFETY BELT

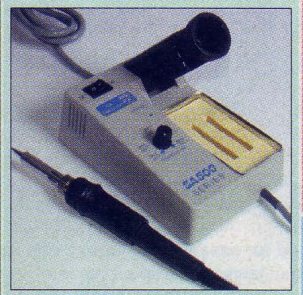



Be more visible at night. Has EL light across back of belt. Simply clip on over clothing.

**Cat. SL-2880**

**Was $24.95 Save $14.95** **Now $10**

## OK SOLDERING STATION SELLOUT



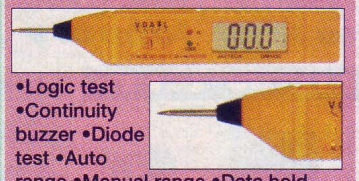
Features: •Dial up temperature 315° - 427°C •Closed loop temperature control •Zero voltage heater switching. See 96 Cat. page 161 for full details. **Cat. TS-1600**

**Was $189.50**

**Save $30.00**

**Jan $159.50**

## DIGI PROBE MULTIMETER



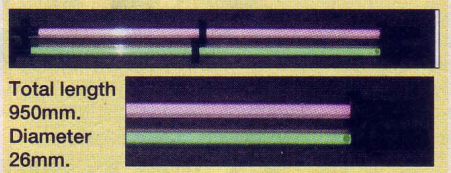
•Logic test •Continuity buzzer •Diode test •Auto range •Manual range •Data hold. See 96 Cat. page 29 for full details.

**Cat. QM-1420**

**Was $54.95 Save $10**

**Jan $44.95**

## 12 VOLT NEON UNDERBODY TUBES



Total length 950mm. Diameter 26mm.

Pink - **Cat. ST-3122** **Were $49.95ea**

Green - **Cat. ST-3124** **Save $20**

**Jan $29.95 each**

## PHOTO FILE ORGANISERS

They will store photo sizes 3.5" x 5", 4" x 6" and 5" x 7" as well as negatives, CD's etc. They have moveable plastic dividers and paper index cards and are dust proof, water resistant and archival safe.

NEW

**SMALL**

Holds up to 600 photos. Size 220(W) x 185(H) x 215(D)mm **Cat. HB-5200**

**Retail Price $14.95**

**NOW $9.95**

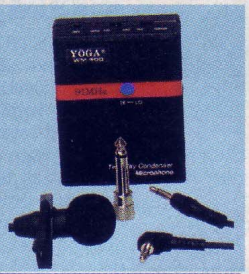
**LARGE**

Holds up to 1400 photos. Size 450(W) x 185(H) x 215(D)mm

**Cat. HB-5202**

**NOW $29.95**

## TIE CLIP WIRED/WIRELESS



This mic works extremely well in both FM wireless and wired mode. It consists of a black box (about the size of a packet of 20 cigarettes) which clips on your belt or pants. This box accepts the lead in from the tie clip microphone, holds the batteries and the cable to the amplifier runs from here. For a small mic if offers excellent frequency response & tonal quality.See cat P146 for full details **Cat. AM-4078**

***Was $49.95 Jan $39.95 Save $10***

## TURN YOUR SURPLUS STOCK INTO CASH!

Jaycar buys surplus/distress stock of most electronic products from components to built products. If you have marketable quantities of stock you need to clear contact Bruce Routley or Mark Ostro on Phone: 02 9743 5222 Fax: 02 9743 2066

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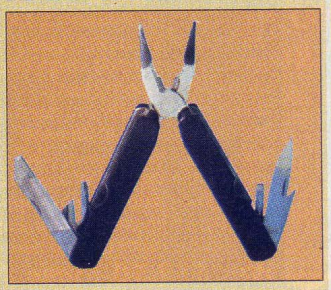
## THIS IS NOT A LEATHERMAN!!

Opens up to reveal a pair of pliers, as well as pocket knife attachments - large knife, small knife, bottle opener, screwdrivers, can opener, file. Supplied in black leather case with belt clip. Folded size: 100(L) x30 x20mm.



Cat. TH-1900

**Was $19.95 Save $5 Jan $14.95**

## IEC POWER LEAD SPECIAL

IEC line cord straight entry to bare ends. Length 2 metres. Colour black.

**Cat. PS-4100**

**Was $6.50**

**Save $2.00**

**Jan $4.50**

## VACCUUM STORAGE CASE

SAVE A FORTUNE

Store valuables - (disks, CD's, photos, cameras, film etc, etc.) in a . See 96 catalog page 179 for full details.

**Cat. HB-5800 Normally $39.95**

**Now $15 Save $24.95**

WHAT A FLOP

**PUMP TO SUIT: Cat. HB-5802**

**Normally $17.95 Now $6 Save $11.95**

## SAVE ON CORDLESS HEADPHONES

See 96 catalogue page 56 for full details.

**MONO Cat. AA-2002**

**Was $59.95ea. Save $10**

**Jan $49.95 ea**

**STEREO Cat. AA-2004**

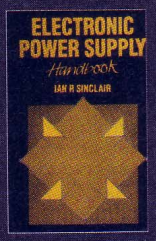
**Was $79.95ea Save $20**

**Jan $59.95 ea**

Note:- AC mains plug pack not supplied. Requires 12V DC 400mA. Use existing one or Cat. MP-3006 $15.50

## NEW BOOKS!

### Electronic Power Supply Handbook




This book covers many types of supplies including: linear supplies, switch mode supplies, simple AC supplies, inverters and battery supplies. It also includes stabilisation and regulators, explains operating principles and gives typical circuits. Ideal for technicians, students and enthusiasts. Softcover, 136 pages, 212 x 135mm.

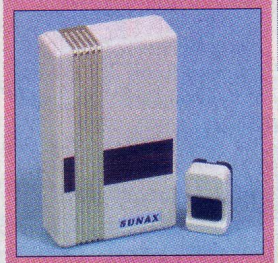
Cat. BM-2494 **$14.95**

### Electronic Alarms Circuits Manual

Alarms have many applications in the home, industry and in cars. They can be activated by many means including voltage and current drop, ressistance, light and heat levels. This book includes 140 useful alarm circuits that deal with the following, plus more ..... contact operated, burglar alarm, temperature operated, light sensitive, miscellaneous, automobile, instrumentation and infra red. Softcover, 124 pages 214 x 137mm.

Cat. BM-2495 **$14.95**

## 16 TUNE DOORBELL




Complete with pushbutton.

**Cat. LA-5012**

**Cat Price $14.95**

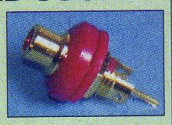
**Jan $8.95**

**Save $6.00**

## JAYCAR STORES ARE NOW ON EFTPOS

## HIGH QUALITY GOLD INSULATED SOCKET

Requires 15mm panel hole.

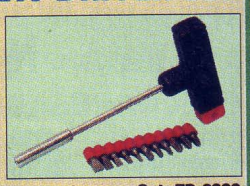


**Red Cat. PS-0260 Black Cat. PS-0261**

**Normally $4.25 each**

**Jan $2.95 ea 10+ $2.25ea.**

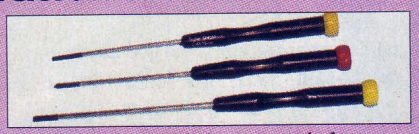
## MAGNETIC "T" BAR SCREW DRIVER SET



This handy kit incorporates a T bar screwdriver with cushion grip for extra torque. It has a powerful magnetic chuck which accepts any of the metric bits. There are 11 bits included in the pack - Philips No 1, 2 or 3. Slotted No 3, 4, 5, 6 and 8 / Torx No T15, T20 and T30. An ideal tool set for any tool or glove box, kitchen cupboard etc. **Cat. TD-2022**

***Was $5.95 January $4.50 Save $1.45***

## SUPER LONG PRECISION SCREWDRIVER SET



This set includes three screwdrivers, two slotted and one Phillips. Ideal for working on computers, TV's, communications instruments, radios, cameras, VCR's, clocks etc. The blades are made from Nickel Chrome Molybdenum steel. Drivers are:- 1 x slotted 2.4mm x 75mm, 1 x slotted 3.0mm x 100mm, 1 x Phillips No.0 x 75mm. **Cat. TD-2006**

***Was $7.95 January $5.95 Save $2.00***

## CELLULAR TELEPHONE EARPHONE WITH MICROPHONE

Many new generation digital cellular phones have a 2.5mm socket on them for a combination hands free mic & earphone. This allows you to talk hands free on your portable phone in your vehicle. Consists of one inner ear speaker, then the microphone 160mm down the cable, then 90mm further is a tie/collar/shirt clip to hold it in place. See cat P145 for details. **Cat: AA-2025**

***Was $19.95 Jan. $14.95 Save $5.00***

## NEW KIT

NEW

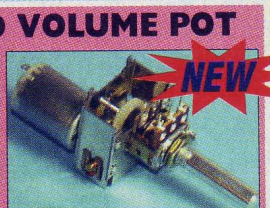
## HEAVY DUTY WIRE STRIPPER, CUTTER AND CRIMPER

Designed for easy wire stripping. The Alloy steel jaws can strip all types of wire from AWG 10 - 26 gauge (0.13 - 6.0mm). Also incorporates quality crimping jaws. • For insulated terminals and non insulated terminals .

**Cat. TH-1826 Was $23.50**

**Now $19.95 Save$3.55**

## MOTORISED VOLUME POT



NEW

This motorised pot is ideal for remote volume controls. It is used in the new Electronics Australia Pro Series Hi Fi preamplifier. Its a 20K dual gang log pot with 1/4" shaft and a small motor and gearing mounted behind the pot. Allows motor driving and manual operation. Specifications •Rotational torque: 100 - 450gf.cm. •Motor voltage: 3 - 6 (4.5V std.) VDC. •Rotational speed: 10 +/-3 sec. / 300° at 4.5V DC. •Max. operating current: 100 mA at rotation, 150 mA at end slip. Supplied with full spec.

**Cat. RP-3850 $17.95**

## SMOKE ALARM CONTROL PANEL KIT

(REFER: SILICON CHIP JANUARY 1997)

If you have a large or multi-storey house then a smoke alarm may not be heard in all areas. By using this controller kit, when one detector is triggered, all alarms will sound. This kit will operate standard smoke detectors which are modified by adding a small PCB in place of the detector's battery. Each detector is then powered by the mains-operated controller. Operational battery backup is provided if mains power fails. Features: Uses commercial smoke detectors; monitor and power up to 10 detectors; extra alarm output; 4 wire connection between detector and panel; plus many other features too numerous to list. Controller kit is supplied with case transformer PCBs plus electronic components. Detector modification kit (one required per detector) KC-5218 $5.95

**Cat. KC-5217 Controller $139.00**

**Optional 12V 1.2AH SLA Battery, SB-2480 $28.50**

**BULK USERS - CONTACT OUR WHOLESALE DEPT FOR SPECIAL PRICING**

**(02) 743 5222**

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**MAIL ORDER - FREECALL FOR PHONE ORDERS 1800 022 888**

Jaycar vifa

## JV100 10" 3 WAY 5 SPEAKER KIT GIVEAWAY!!!

The JV100 has five speakers in each cabinet, the 10" woofer is the Vifa long stroke driver M26WR, the 2 midranges are Vifa P13WG with 5" cones, and the 2 tweeters are Vifa D25AG aluminium domes. The amazing bass is a result of the M26WR's stiff conical paper cones, huge 2" voice coil and 1kg plus magnet weight. Power handling is 160WRMS, a long term rating of 300 watts and a short term pulse power of 500 watts. Call into any Jaycar store for an audition. The enclosure is nominally 65 litres with two 66mm ports. Cabinet size is 925(H) x 320(W) x 310(D)mm. Very well proportioned and not too tall. If you want to make your own cabinets, plans are available. The crossovers are fully built, and are based on the 2nd order type. Polyswitch speaker protectors are included in the crossover.

SPEAKER KIT: Includes two 10" woofers, four 5" midranges with Vifa made plastic backs which gives them their own enclosures, 2 crossovers with polyswitches, innerbond and self tapping screws for mounting speakers and crossovers

CABINETS: These are supplied pre-built and finished in black "blackwood" veneer. Grills supplied with speaker cloth mounted. Simply solder the crossover wires & screw the speakers in. The speaker kit can be used with amps capable of producing 30 to 300 WRMS.

| NORMALLY | | JANUARY | |
|---|---|---|---|
| SPEAKER KIT | Cat. CS-2550 $1,199pr | SPEAKER KIT | $799pr Save $400! |
| CABINETS | Cat. CS-2552 $378pr | BUY TOGETHER | $1050 Save $400! |
| BUY TOGETHER | $1499pr | | |

FOR FREIGHT COSTS ON COMPLETE KIT CONTACT OUR MAIL ORDER DEPARTMENT.

Quote from Leo Simpson - Silicon Chip on JV100's "This speaker really performs, with prodigious power handling and beautiful bass down to below 30Hz. But as well as power handling and extended bass response, the system is very satisfying in its handling of all types of music with a smooth midrange and very clean treble reproduction."

## ANALOGUE MULTIMETER RUNOUT

Quality Korean Hung Chang 20KΩ/ volt meter. 23 ranges, continuity buzzer, battery tester. See 96 cat. page 30 for full details.

**Cat. QM-1022**

**Was $39.95 Save $7**

**JANUARY $32.95**

## "Bullet" Type Mercury Tilt Switch

Imagine the lead slug of a .38 calibre cartridge and this is the size of the tilt switch. Steel chamber houses a small amount of mercury. The chamber is hermetically sealed. Connections are by a solder tab and post. Ideal for motor bike alarms, robotics or any applications where large movements need to be detected. Measures 9mm dia x 17mm long (less solder post) **Cat. SM-1041**

NEW

**$2.95 ea / Pack of 20 for $40**

## Quality Mercury Tilt Switch

Mercury won't "wet" to steel. This switch features a TO-3 size steel chamber which contains about 15g of mercury with a steel electrode inside. The entire chamber is hermetically sealed and externally nickel plated. Connections are by a 1/4" male Q.C. tab. One connector doubles as a mounting bracket. Ideal as a motor bike alarm switch or any application where major movements need to be detected. Rated at 100V at 2A (max) resistive load. Measures 22mm dia, 30(H)mm (less nylon bush), 30(D)mm (total)

**Cat. SM-1042**

**$7.95 ea**

## SAVE $20 ON CENTRE SPEAKER

Speaker has 2 x 4" woofers plus tweeter. Shielded, so will sit on TV. Power handling 50WRMS. Size 335(W) x 110(H) x 145(D)mm See cat. page 48.

**Cat. CS-2510**

**Was $99.95 Save $20**

**Jan $79.95**

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## FABULOUS NEW PLAYMASTER PRO SERIES IV PREAMP

REF: Electronics Aust Dec 96 / Jan 97

This totally new preamp is the ultimate development from the Series II preamp. The preamp features simple to operate preamp-out-to-record facilities. (eg. to tape, recordable CD or other media). The preamp also features five, yes 5, line level inputs as well as phono. Another fantastic feature is the remote control volume adjustment. The Jaycar & EA Staff co-operated very closely on this project. We, for example, provided the prototype componentry. Not only is the Jaycar kit true to the prototype, in keeping with the Jaycar quality approach we include at no extra charge, quality metal film (not cheap carbon) resistors, the quieter 5534A op-amps, quality IC sockets and gold plated RCA's for all input and output connections! There is a nasty rumour going about that one major kit supplier will be supplying a cheap chassis transformer in lieu of the quality toroid as used in the prototype. BE ASSURED, JAYCAR CUSTOMERS, THAT WE WILL BE PROVIDING THE ORIGINAL, QUALITY TOROID IN OUR KIT - BEWARE OF CHEAP COMPROMISE KITS. In order to keep the kit cost down, Jaycar will not be providing an expensive IR remote especially designed for this kit. Instead we provide a PCB based "mini kit" which you can use to reprogramme existing learning remotes which you might already own. (If you don't the AR-1710 $43.95 or our AR-1705 $69.95 are ideal). •FREQUENCY RESPONSE (Line inputs, typical load) •Bypass mode: 15Hz to 30kHz +0/-1dB TOTAL HARMONIC DISTORTION (20KHZ bandwidth, typical load, at 1VRMS output) •Bypass mode: less than 0.002% SIGNAL TO NOIS RATIO (20KHZ bandwidth, unweighted, at 1VRMS output) •Bypass mode: -105d

**Cat. KA-1790** **Only $299 Complete**

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Any combination can be connected together to give different sounds in a rotating manner. If you were to describe the sounds you would say whoop whoop, laser gun, two tone warbler, screamer, beep beep. Give your car or house alarm a unique sound to others. Operated on 12 volt DC. Size 105(H) x 105(W) x 110(L)mm.

Cat LA-5705 **Was $29.95**

**JAN $19.95 Save $10**

## NEW CASE

3 pin plug in plug pack case available on its own. Make your own plug-in power supplies. OEMs, contact us for great prices. **Cat. HB-5900**

**Only $5.95**

## CABLE CLIPS

Available in packets of 25 and are priced up to 50% less than others.
**5 SIZES AVAILABLE**

**3 x 5mm**
Cables up to 3mm high by 5mm wide for 4 core flat telephone, duty speaker cable
**Cat. HP-0680**
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Cable up to 5mm high by 8mm wide. For medium speaker cable and 6 core flat telephone cable.
**Cat. HP-0682**
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**6 x 10mm**
Cable up to 6mm high by 10mm wide. Suits 8 way flat telephone cable & jumbo speaker flex.
**Cat. HP-0684**
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**5 - 7mm Expandable**
Suits round cables 4 core alarm cable, 75Ω thin coax and 50 Ω thin coax.
**Cat. HP-0692**
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Suitable for round cable, 6 core alarm cable, air spaced coax and Belden coax.
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## EXTREMELY LARGE ANTISTATIC MAT

This mat will just about cover the whole top of a desk or work station!! It measures 1 meter x .5 meters - Yes 100cm x 50cm. Supplied with two snap type connectors at one end (for left or right handed use) for ground strap (which is supplied). Mat is over 3mm thick and has a hard wearing face over a dense sponge rubber base. Amazing low price.

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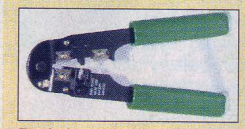
## Save Big $$$ On Modular Telephone Crimp Tools



**4P2C & 4P4C** Cat. TH-1930
Was $24.95 Save $8
**Now $16.95**

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## BLUE LED BARGAINS

3mm 14MCD Cat. ZD-1751
WAS $3.95 **NOW $2.95** SAVE $1

5mm 14MCD Cat. ZD-1727
WAS $2.95 **NOW $2.20** SAVE 75¢

## Heavy Duty Jumper Lead Bargain

We received a shipment of these recently, and found that the connection to the alligator clips had not been soldered - only crimped. Due to this the wires easily pull out and contacts are poor. So we are selling them at a bargain price. It will take about 20 mins to solder them all. Alligator clips are large size - about 50mm long. Cable length is approx 300mm. 10 leads supplied - 2 of each colour. **Cat. WC-6021 Were $7.95 Save $4**

**THESE ARE ONLY $3.95**

## "K" TYPE THERMOCOUPLE BARGAIN

Our suppliers sent us a shipment of these DMM temperature thermocouples without the probe. Grab a spare.

**Cat. QM-1283 Normally $12.95 (with probe)**

**THESE ARE ONLY $5 EACH**

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**CANBERRA ACT** •11 Kembla St. Fyshwick •Ph:(06) 239 1801 •Fax:(06) 239 1821 •Mon/Fri:9-5.30 •Sat:9-1pm

**MELBOURNE CITY** •Shop 2,45 A'Beckett St•Ph:(03) 9663 2030•Fax:9663 1198 •Mon/Fri:8.30-5.30 •Fri:8.30 •Sat:8.30-4 •Sun:10-4pm

**COBURG VIC** •266 Sydney Rd •Ph:(03) 9384 1811 •Fax:(03) 9384 0061 •Mon/Fri:9-5.30 •Fri:8.30 •Sat:9-4pm

**SPRINGVALE VIC** •887-889 Springvale Rd Mulgrave. Nr Cnr. Dandenong Rd •Ph:(03) 9547 1022 •Fax:(03) 9547 1046 •Mon/Fri:9-5.30 •Fri:8.30 •Sat:9-4pm

**HOBART** •140 Campbell St. Hobart •Ph: (03) 6231 5877 •Fax: (03) 6231 5876 •Mon/Fri: 9-5.30 •Sat:9-4pm

**SYDNEY CITY** •129 York St •Ph:(02) 9267 1614 •Fax:(02) 9267 1951 •Mon/Fri: 8.30-6pm •Thurs:8.30pm •Sat:9-4pm

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# PRODUCT SHOWCASE

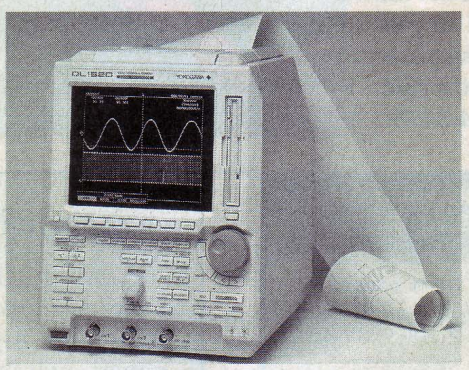
## Kenwood VA-2230 audio analyser

The Kenwood VA-2230 audio analyser combines the functions of a signal generator (10Hz to 110kHz), electronic voltmeter, distortion meter, frequency counter and DC voltmeter. The instrument is provided with a GPIB interface, permitting external programming and data output.

Features include measurement of true RMS values; a high speed signal generator utilising direct digital synthesising; SINAD measurement; dual channel input/output measurement for crosstalk, separation and L/R ratio; a frequency counter and extended AC level frequency range to 210kHz; and a distortion meter with THD and harmonic analysis functions (2nd to 10th harmonic).

For further information, contact Nilsen Technologies, 150 Oxford St, Collingwood, Vic 3066. Phone (03) 9419 9999; fax (03) 9416 1312; freecall 1800 623 350.

## Yokogawa DL 1520 portable oscilloscope



The new Yokogawa DL 1520 digital oscilloscope is a 2-channel instrument with a maximum sampling speed of 200Ms/s and a bandwidth of 150MHz, processing repetitive signals with an equivalent speed of 20Gs/s. In the envelope mode of operation, the instrument will capture events with durations as short as 20 nanoseconds.

The DL 1520 is equipped with extension functions, including arithmetical operations and FFT analysis. Screen displays can be saved in TIFF, BMP, PostScript and HPGL formats on the MS-DOS compatible floppy disc drive.

The memory length is a maximum of 20K word (in roll mode) and this, combined with an optional built-in printer, makes the DL 1520 suitable for use as a real time recorder with an equivalent maximum chart speed of 16.7mm/s. Screen displays are as fast as 60 updates per second, even when mathematical functions or envelope peak detection modes are employed.

Communication options available include GPIB, RS232 and a combined GPIB and Centronics interface.

For further information, contact Yokogawa Australia Pty Ltd, Private Mail Bag No 24, PO Box North Ryde, NSW 2113. Freecall 1800 500 085; phone (02) 9805 0699; fax (02) 9888 1844.

## Digital video disc recorder

Amber Technology has announced the Video Solution VMOD-100 video recorder which employs removeable magneto-optical discs. Manufactured by Future Equipment Design (FED) of Germany, the VMOD-100 is a drop-in replacement for analog VTRs and does not require a computer interface. The entire recorder is housed in a half-width 3U enclosure and all controls are on the front panel.

The VMOD-100 offers all digital operation, giving fast random access (0.3 seconds maximum) and no signal degradation. Takes can be played and repeated without wear and tear of heads or media. Video signals are recorded in real time like a normal VTR with assemble and insert recording options. Video inputs and outputs are on both composite and Y/C (S-video) connectors and the signal can be viewed on any conventional video monitor.

The basic system is equipped with one MOD drive (expandable to seven drives), two digital sound channels and one RS-422 control interface which allows connection to conventional video editing systems. Variable MPEG data compression is employed according to the desired picture quality. Recording time can be set between 28 minutes (S-VHS quality) and 60 minutes (of-line editing) per MOD drive, with a capacity of 1.3Gb per disc.

For further information, contact Amber Technology, Unit B, Skyline Place, Frenchs Forest, NSW 2086. Phone (02) 9975 1211; fax (02) 9975 1368.

## Onkyo home theatre receiver

Amber Technology has announced the Onkyo TX-SV535 AV Surround Receiver. It is rated at 80W RMS/8Ω per channel in stereo mode or 65W RMS to the front left, centre and right channels and 25W RMS to each of the rear channels in surround mode. In place of inexpensive hybrid IC amplifiers found in lesser-quality units, all of the TX-SV535's five output channels are powered by completely discrete amplifier blocks, with individual components (no ICs).

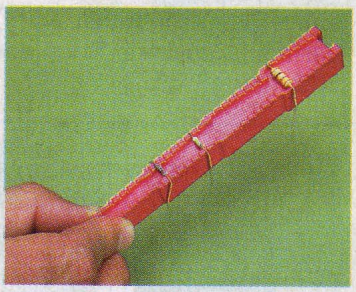
There are separate pre-out terminals for the front L/C/R channels, rear L/R channels and a subwoofer output. The TX-SV535 is equipped with digital Dolby Pro Logic surround sound and five surround modes: Dolby Pro Logic, Dolby Pro Logic Theatre, Hall, Live and Arena.

The Onkyo TX-SV535 measures 455 x 170 x 389mm, weighs 11.8kg, is finished in black brushed aluminium and has a recommended retail price of $1349.00.

Onkyo high fidelity and home theatre products are available from authorised dealers and are distributed in Australia by Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest, NSW 2086. Phone (02) 9975 1211; fax (02) 9975 1368.

## Handy component lead bender

This small lead bender will enable precise bends for components with body lengths of 7.5, 10, 12, 15 and 17.5mm. It is moulded in red plastic and is available at $2.95 including postage from CIL Distributors Pty Ltd, PO Box 236, Castle Hill, NSW 2154. Phone (02) 9634 3475.



## 2.1Gb disc runs at 4500 rpm

Seagate Technology Inc has released a 2.1Gb 3.5-inch hard disc drive with a special cover package designed to increase reliability.

Called Seashield, the cover is placed over the PC board and is secured to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***RF Products***

**FMTX1 Kit $49**
Single transistor 2.5 Watt Tx free running 12v-24V DC. FM band 88-108MHz. 500mV RMS audio sensitivity.

**FMTX2A Kit $49**
A digital stereo coder using discrete components. XTAL locked subcarrier. Compatible with all our transmitters.

**FMTX2B Kit $49**
3 stage XTAL locked 100MHz FM band 30mW output. Aust pre-emphasis. Quality specs. Optional 50mW upgrade $5.

**FMTX5 Kit $98**
Both a FMTX2A & FMTX2B on 1 PCB. Pwt & audio routed.

**FME500 Kit $499**
Broadcast specs. PLL 0.5 to 1 watt output narrowcast TX kit. Frequency set with Dip Switch.

**220 Linear Amp Kit $499**
2-15 watt output linear amp for FM band 50mW input. Simple design uses hybrid.

**SG1 Kit $399**
Broadcast quality FM stereo coder. Uses op amps with selectable pre-emphasis.

Other linear amps and kits available for broadcasters.

**AWA FM721 FM-Tx board $19**
Modify them as a 1 watt op Narrowcast Tx. Lots of good RF bits on PCB.

**AWA FM721 FM-Rx board $10**
The complementary receiver for the above Tx. Full circuits provided for Rx or Tx. Xtals have been disabled.

**MAX Kit for PCs $169**
Talk to the real world from a PC. 7 relays, ADC, DAC 8 TTL inputs & stepper driver with sample basic programs.

**ETI 1623 kit for PCs $69**
24 lines as inputs or outputs DS-PTH-PCB and all parts. Easy to build, low cost.

**ETI DIGI-200 Watt Amp Kit $39**
200W/2 125W/4 70W/8 from ±33 volt supply. 27,000 built since 1987. Easy to build.

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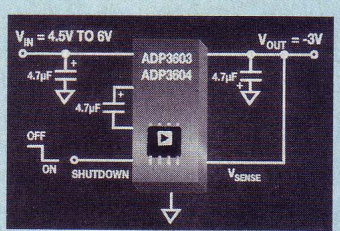
## High-frequency inverter ICs



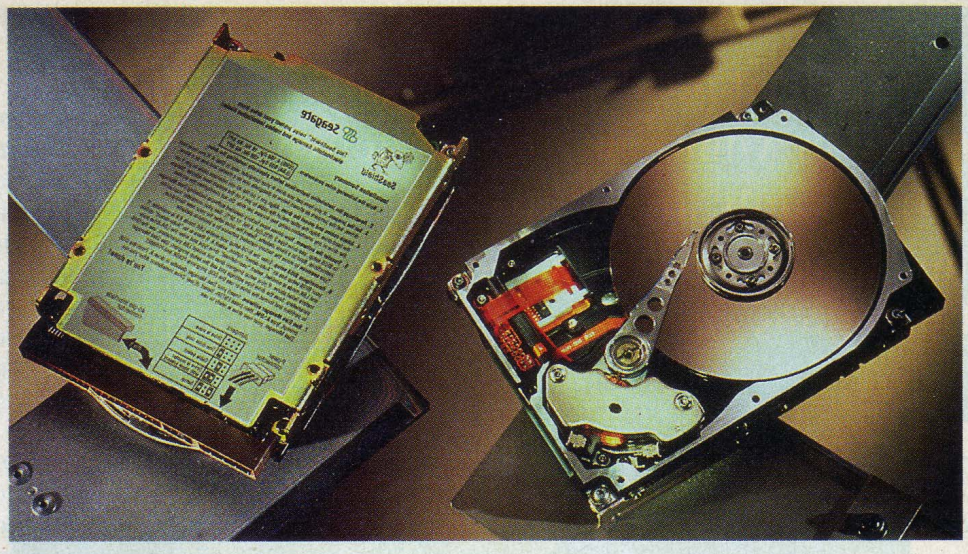

Analog Devices' new ADP3603 and ADP3604 high-frequency, switch-capacitor inverters deliver a regulated output with high efficiency and low voltage loss and eliminate the need for external inductors.

The ADP3603 and ADP3604 provide up to 50mA and 120mA of output current respectively, with ±3% output error, at a switching frequency of 120kHz. Output ripple is only 15mV and 25mV, respectively. Their high switching frequency makes operation possible with capacitors as small as 1µF.

The regulators dissipate less than 400mW and users can enable a fast shutdown mode in less than 5ms, dropping the quiescent current to 1.5mA.

The output is fixed at -3V for input voltages ranging from +4.5 to +6V. The ADP3603's and ADP3604's load regulation is 0.12mV/mA and 0.32mV/mA, respectively. Both regulators are available in small outline 8-pin SOICs with an operating temperature range of -40°C to +85°C.

For further information, contact Hartec, 205A Middleborough Road, Box Hill, Vic 3128. Phone 1 800 335 623.



the head-disc assembly. It helps reduce the chances of exposure of electrical components to electrostatic discharge (ESD) as well as knocks and bumps which can occur during the installation process.

Running at 4500 rpm, the new drive has an average seek time of 12.5ms.

For further information, contact Seagate Technology Australia Pty Ltd, 1st Floor, 17-18 Walker Place, Wetherill Park, NSW 2164. Phone (02) 725 3366.

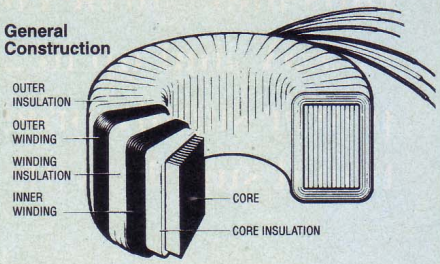
## Computer power supplies

For most computers, when the power supply fails it is more economical to replace than repair it. However, many suppliers will only sell a power supply together with the case; the original case must be junked along with the supply.

To remedy this, Computronics is now stocking a range of computer power supplies. These can replace a faulty unit or upgrade a lower powered unit. Currently stocked are 200W and 250W models in two case sizes, supplied with mounting screws and flying leads to allow quick reconnection. All models are UL-approved.

For further information, contact Computronics International Pty Ltd, 31 Kensington St, East Perth, WA 6004. Phone (09) 221 2121; fax (09) 325 6686.


**TOROIDAL POWER TRANSFORMERS**

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# Neville Williams – a tribute

Neville Williams died on 7th November, 1996. Long-time readers of *ElectronicsAustralia*, and before that *Radio & Hobbies*, will recall Neville Williams being at the helm of that magazine for a very long time – he was the magazine!

I first met Neville Williams in March 1967 and by that time he had been regarded as an institution for many years. He had run the magazine during the war years while the editor John Moyle had served in the RAAF. John Moyle had returned after the war and continued until his death from cancer in 1959. In the meantime Neville had continued as his righthand man, producing many notable valve amplifier designs.

Up until the mid-1970s, the magazine was effectively the only voice of the Australian electronics industry and under WNW (Walter Neville Williams), *Radio & Hobbies* and later *Electronics Australia*, effectively commented upon and chronicled developments, particularly during the introduction of television.

In the early 1970s, Neville recognised that industry developments had become too diverse for effective coverage by *Electronics Australia* and so he started the trade magazine *Electronics News* which is now run under the auspices of Reed Business Publishing.

Neville was noted for his extensive knowledge of valve technology, much of which he gained during his time atAmalgamated Wireless Valve Co Ltd in the prewar years. During that time he had contributed to the compilation of the noted *Radiotron Designer's Handbook* which was edited by Fritz Langford-Smith.

A tall, large-framed man, Neville was essentially a quiet and retiring person, quite different from the persona he projected in his prodigious writings for the magazine. Perhaps the most notable of these were those featured in "Let's Buy An Argument" which he wrote for more than 30 years. Today, there are many eminent engineers who would have been inspired by Neville's writings and who would have tentatively ventured to "buy an argument" during those years.

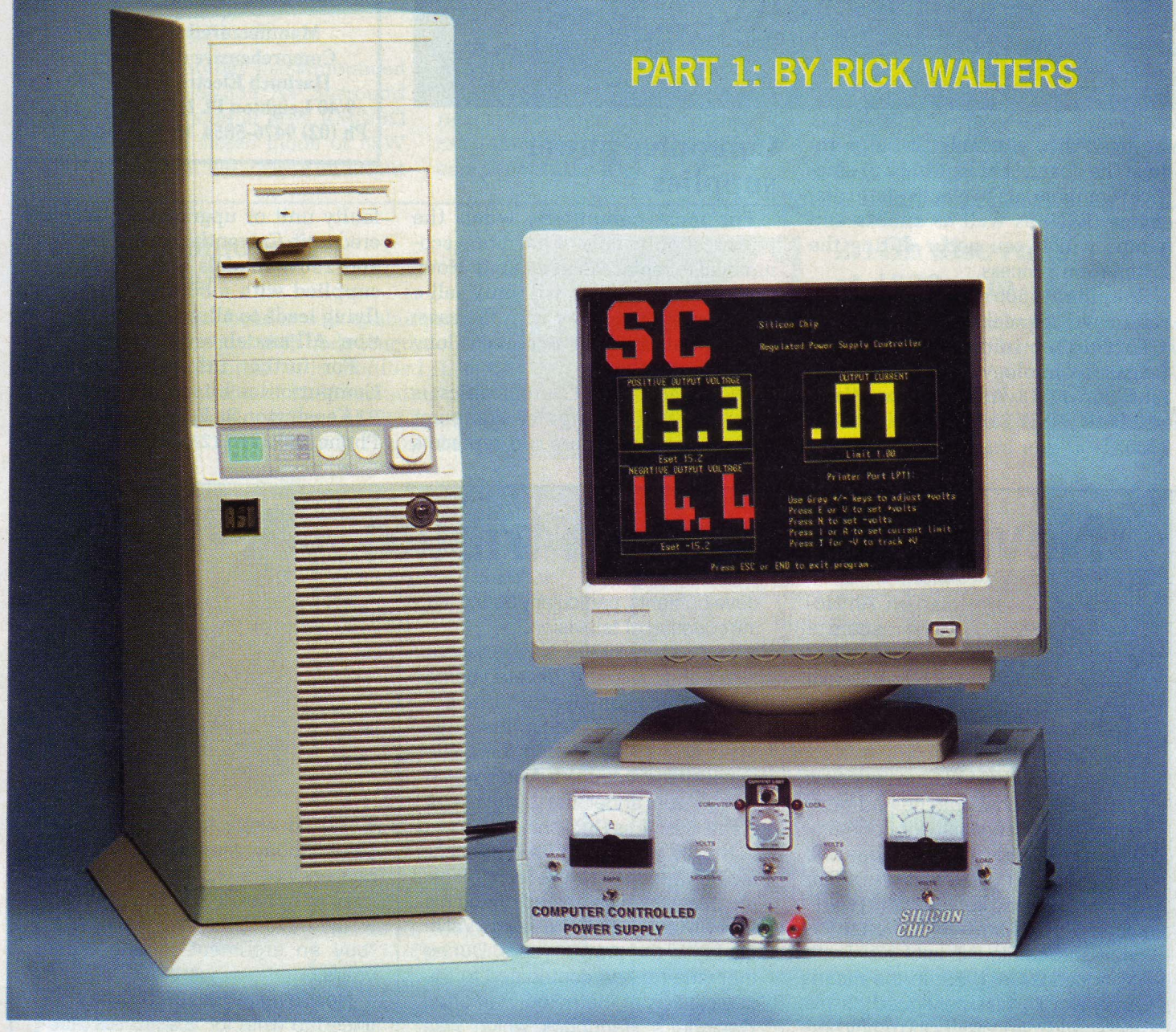
Neville retired in 1983 but he continued to write for *Electronics Australia* and he also wrote for *SILICON CHIP* for a number of years.

I and a number of others at *SILICON CHIP* owe a considerable debt to Neville Williams as we worked with him for many years. May he rest in peace.

**Leo Simpson**

This power supply has balanced positive and negative supply rails and can be controlled by your computer to deliver up to ±25.5V and up to 2.55A. Not only are all the functions of the power supply programmable but you can also use it as a conventional supply with all functions controlled from its front panel.

PART 1: BY RICK WALTERS




# COMPUTER CONTROLLE

WE HAVE PUBLISHED quite a few power supplies in the past but this is the first one to have the option of computer control via the parallel port of a PC-compatible computer. In fact, you can build this project as a conventional power supply with normal front panel controls for voltage, current limit and so on, or with the addition of an extra PC board linked back to your computer's parallel port, you can have full computer control via an on-screen menu.

The computer program allows you two options: (1) full variable control of voltage and current from the computer keyboard and (2) monitoring of voltage and current with these values displayed on the VGA monitor.

Virtually any PC-compatible computer can be used: 286, 386, 486 or Pentium. The program is not Windows-based, although you could run it from within Windows if desired. Here's your chance to press that old 286 or 386 into service and make it do something useful again if it has been relegated to the back room.

## Why programmable?

Why not? There are many processes which require a certain voltage (or current) for a particular time, then a reduced voltage after that. Or maybe you want to monitor the current drawn over a long period and you can't sit watching the power supply all day, can you?

You might want to control a plating job for a couple of hours for example, or maybe charge a nicad battery. The charging procedure usually specifies 14-15 hours at 1/10 the rated capacity of the cell. Then, if they are not going straight into service, they can put onto a trickle charge to keep them topped up. This would be a doddle for this programmed power supply.

## Features

The SILICON CHIP Computer Controlled Power Supply can provide up to ±25.5V at up to 2.55A. These odd maximum values come about because we use an 8-bit parallel printer port and an A/D (analog to digital) converter which has a maximum conversion count of 255. To exploit the full conversion range of this device we selected the aforementioned voltage and current values.

A front panel switch allows instant changeover from computer control to local (front panel) setting capability. LED indicators show whether the supply is in local or computer mode.

In the "local" mode the voltages of

## Specifications

1. Positive & negative supplies, each adjustable from 0V to 25.5V
2. Local individual voltage settings; computer-controlled individual voltage settings; computer-controlled negative tracking positive
3. Current limiting for both supplies from 10mA to 2.55A
4. Local metering of positive or negative supply voltage
5. Local metering of positive or negative supply current
6. Remote positive voltage setting in 100mV steps from 0V to 25.5V
7. Remote negative voltage setting in 100mV steps from 0V to -25.5V
8. Remote current limit setting from 0 to 2.55A in 10mA steps
9. Remote monitoring of positive and negative output voltages
10. Remote monitoring of positive output current

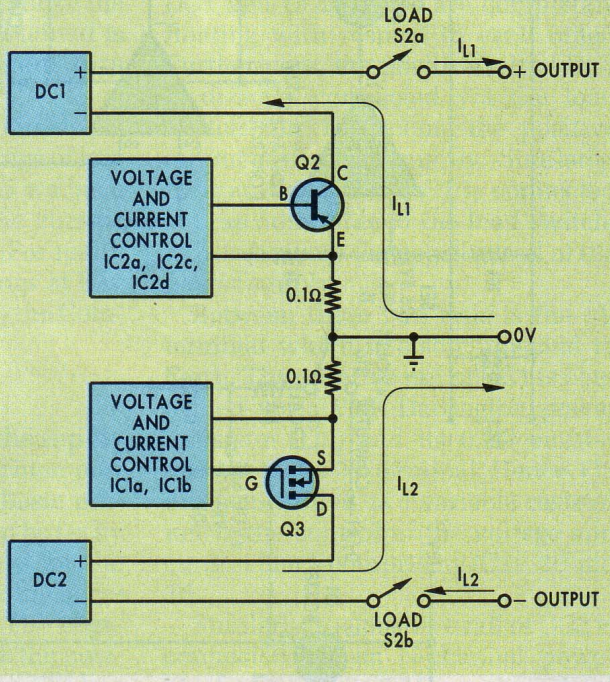
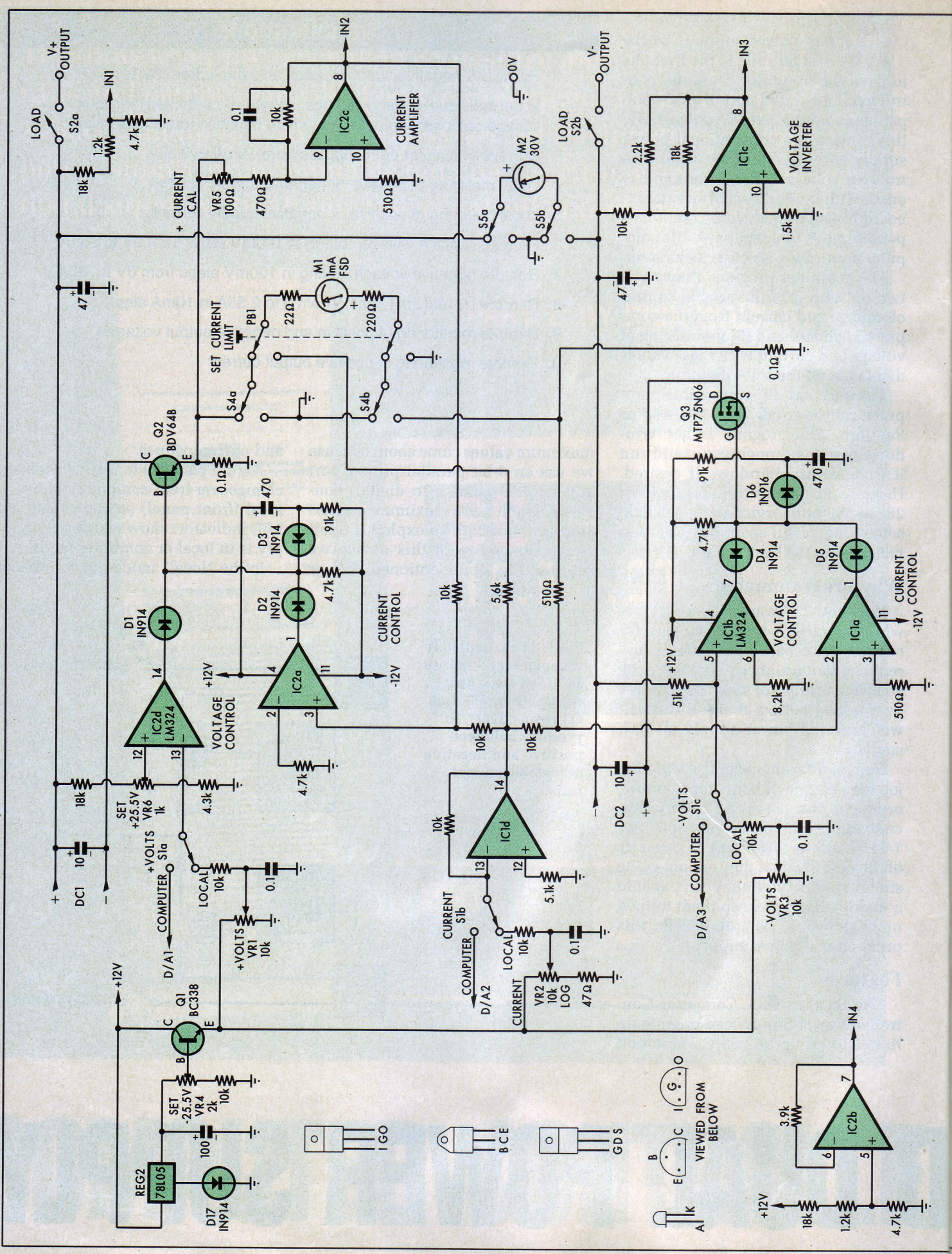



**Fig.1: two completely independent supplies, DC1 and DC2, are regulated by Q2 and Q3 respectively, to produce balanced positive and negative adjustable supply rails.**

# D DUAL POWER SUPPLY


V+ OUTPUT
LOAD
S2a
IN1
1.2k
4.7k
18k
+ CURRENT CAL
VR5 100Ω
470Ω
0.1
10k
IC2c
CURRENT AMPLIFIER
IN2
510Ω
0V
M2 30V
S5a
S5b
V- OUTPUT
LOAD S2b
IN3
2.2k
18k
IC1c
VOLTAGE INVERTER
1.5k
10k
47
M1 1mA FSD
SET CURRENT LIMIT
PB1
22Ω
220Ω
S4a
S4b
Q2 BDV64B
0.1Ω
Q3 MTP75N06
91k
D6 1N916
470
4.7k
D4 1N914
D5 1N914
D3 1N914
D2 1N914
D1 1N914
IC2a
IC2d LM324
IC1b LM324
IC1a
VOLTAGE CONTROL
CURRENT CONTROL
+12V
-12V
10k
5.6k
510Ω
51k
8.2k
IC1d
5.1k
DC1
DC2
SET +25.5V VR6 1k
4.3k
+VOLTS S1a
COMPUTER
D/A1
LOCAL
0.1
+VOLTS VR1 10k
CURRENT S1b
D/A2
VR2 10k LOG
47Ω
-VOLTS S1c
D/A3
-VOLTS VR3 10k
Q1 BC338
SET -25.5V VR4 2k
100
REG2 78L05
D17 IN914
IGO
BCE
GDS
VIEWED FROM BELOW
IN4
IC2b
3.9k
18k
1.2k
4.7k

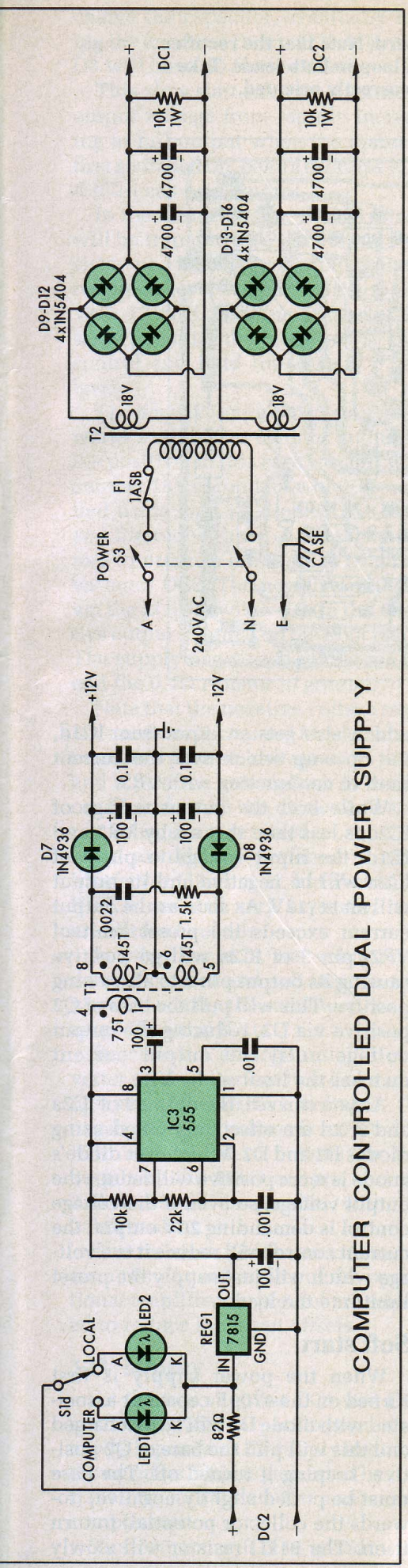



**Fig.2: since the two regulated supplies are essentially independent of each other, a separate ±12V supply is needed to power the op amps. This is provided by IC3 and T1 operating at 27kHz.**

the positive and negative supplies can be independently set anywhere from zero to a maximum of 25.5V and this voltage is shown on the front panel (RHS) voltmeter, which can be switched from the positive to the negative supply.

Similarly, the current drawn from each supply can be read on the ammeter on the lefthand side. This too can be switched from the positive to the negative supply.

A single current limit control sets the maximum current which can be drawn from either supply before it changes from constant voltage to a constant current mode. This limit can be read from the front panel current meter whenever the "current limit" switch is pressed. By using a logarithmic potentiometer for this control the current adjustment range obtained is from around 10mA minimum to a maximum of 2.55A.

In fact, the front panel ammeter is pretty well useless for readings of less than 100mA and that is why we have provided a scale around the current limit knob, as a guide only. For really accurate current limit settings at low values, you need to resort to the Computer Control mode.

## Computer control

In the "computer" mode the supply is controlled from parallel printer port LPT1 or LPT2 using a GW-Basic program. The output voltage can be set by pressing the "V" or "E" keys for the positive and the "N" key for the negative, then entering a value. The negative rail can be made to track the positive rail merely by hitting the "T" key on the keyboard.

The maximum current (current limit) for both supplies can be set by pressing the "I" or "A" keys then entering a value.

Incremental changes to the positive voltage (and the negative voltage in tracking mode) can be made by pressing the + and - keys. The grey keypad keys on the AT keyboard make this a very convenient adjustment.

Once the values are set from the computer it can be switched off or another program can be run, as the values are latched on the digital-to-analog interface board.

This month we propose to cover the operation of the power supply as a self-contained unit. Next month we will give details of the parallel interface board and key points of the program code used to control the supply.

## Circuit description

Fig.1 shows the block diagram of the power supply, minus the interface circuitry required for computer control. We will describe that circuitry next month.

The design approach used in this power supply is quite different from that applied to typical supplies having positive and negative outputs. Normally, for the positive side of the supply, the controlling element, usually a power transistor or Mosfet, is in series with the positive rail. Similarly, a control element is in series with the negative rail.

Fig.1 shows two DC power blocks, DC1 and DC2. These are completely floating with respect to each other. Furthermore, the positive rail of DC1 is directly connected via the load switch S2a, to become the positive output rail of the supply. Similarly, the negative rail of DC2 is connected via the other pole of the load switch, S2b, to become the negative rail of the power supply.

Between these two rails is the 0V terminal which is also connected to Earth. The negative rail of DC1 is connected via a PNP Darlington power transistor (Q2) and its 0.1Ω emitter resistor to the 0V terminal. Hence, Q2 can be regarded as a variable resistor under the control of the voltage and current block comprising IC2a, 2c and 2d.

Similarly, the positive rail of DC2 is connected via an N-channel power Mosfet Q3 and its 0.1Ω source resistor to the 0V terminal. Hence, Q3 can be regarded as a variable resistor under the control of the voltage and current block comprising IC1a & 1b. The two voltage and current control blocks are completely independent. The positive and negative output supply rails do not track each other in this circuit, although, as already noted, they can

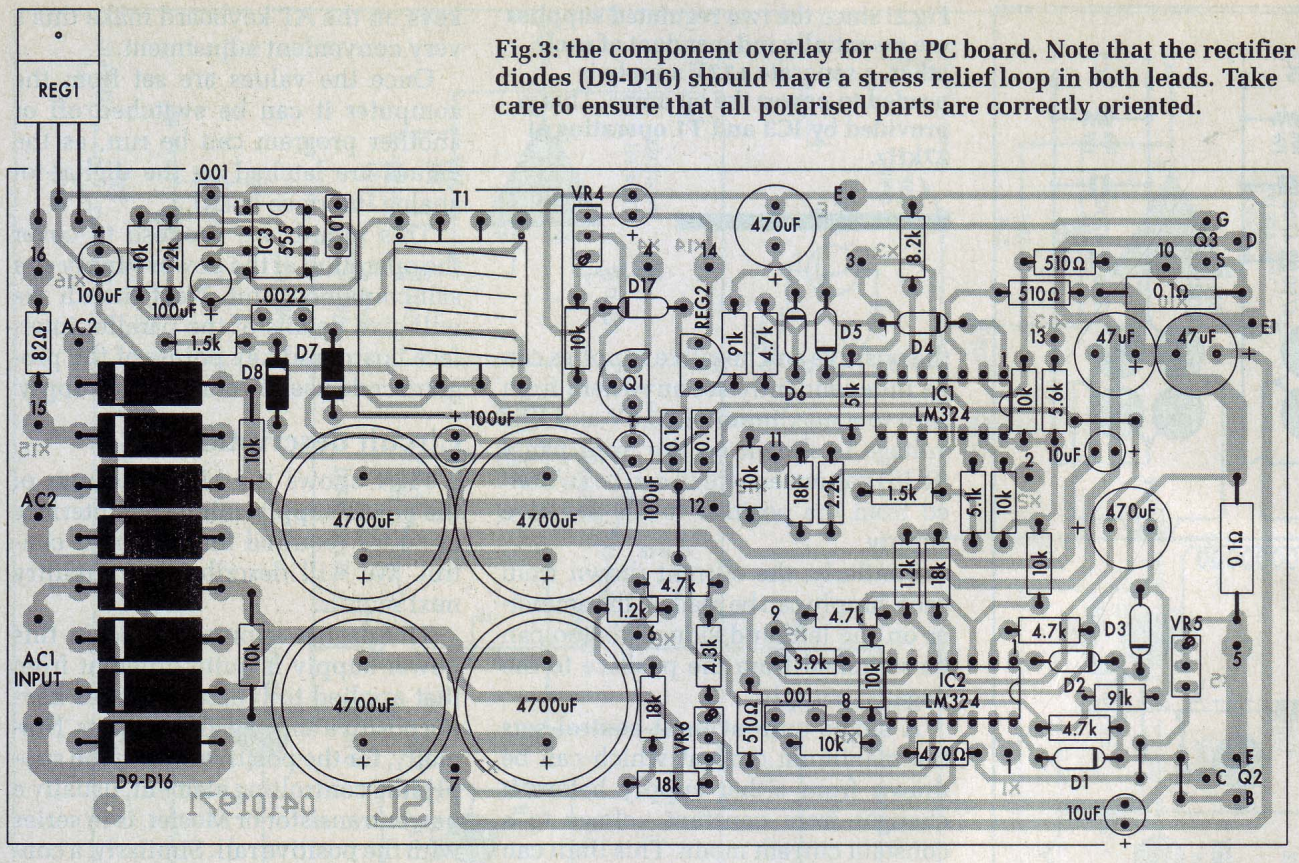



**Fig.3: the component overlay for the PC board. Note that the rectifier diodes (D9-D16) should have a stress relief loop in both leads. Take care to ensure that all polarised parts are correctly oriented.**

be made to do so under computer control.

## Fig.1 looks wrong

If you are accustomed to reading SILICON CHIP circuits, Fig.1 looks wrong. After all Q2 is a PNP transistor with its emitter connected to 0V – surely that is wrong. Similarly, Mosfet Q3 appears to be connected "upside down" in voltage terms, with its source to the 0V terminal. However, if you look at the arrows which show the direction of currents $I_{L1}$ and $I_{L2}$, you will see that they are in the "right" direction for both Q2 and Q3 to function properly.

Note also that the negative rail of DC1 is more negative than 0V. Similarly, the positive rail of DC2 is more positive than 0V. This can only happen if DC1 and DC2 are fully floating with respect to each other.

Now let us look at the full circuit which is shown in Fig.2. The similarities between it and Fig.1 are that the transistors, IC numbers and DC numbers correspond. Hence, Q2 on Fig.1 corresponds to Q2 on Fig.2 and so on. Similarly, DC1 on Fig.1 is the same on Fig.2 etc.

Having noted the similarities between the two diagrams, let us also comment that references to IN1, IN2, IN3 & IN4 on Fig.2 have no reference to the circuit operation described this month. They are the inputs for the optional parallel interface board mentioned earlier.

## Positive supply regulator

We start with an 18V secondary which is rectified using four 3A diodes (D9-D12) and filtered with two 4700µF capacitors to produce around 27V DC. This becomes DC1.

As noted above, transistor Q2 is the series control element for the positive supply, under the control of op amps IC2a, 2c & 2d. The control is best understood in the following way. Q2's base is pulled low, turning it hard on, by the resistor connected to the -12V rail. Also connected to Q2's base are three diodes, D1, D2 & D3 and these effectively shunt current away from the base of Q2 so it is fully controlled rather than being turned fully on.

Op amp IC2d provides the voltage control. VR1 sets the output voltage while VR6 sets the feedback to pin 12 so that the output voltage is exactly 5.1 times the voltage on pin 13. IC2d's output is coupled to Q2 via D1.

IC2c & IC2a provide the current control. IC2c amplifies the voltage across the 0.1Ω emitter resistor of Q2. IC2c's output is fed to mixer op amp IC2a which also gets an input from IC1d, the op amp which sets the current limit in conjunction with VR2.

While ever the output voltage of IC2c is less than that set by VR2 and IC1d, the input voltage to pin 3 of IC2a will be negative and its output will sit at -12V. As soon as the output current exceeds the preset limit of VR2, pin 3 of IC2a will go positive causing its output pin 1 to also swing positive. This will pull the base of Q2 positive via D2, reducing the output voltage until the output current matches the limit set by VR2.

As you can see, the outputs of IC2a and IC2d are effectively ORed using diodes D1 and D2. Whichever diode's anode is more positive will reduce the output voltage, so even if the voltage control is demanding 20V output, the current control will reduce it to a voltage which will just supply the preset limit into the load.

## Soft start

When the power supply is first turned on the 470µF capacitor associated with diode D3 will be discharged and this will pull the base of Q2 positive, keeping it turned off. The base must be pulled slightly negative, (towards the collector potential) to turn it on. The 91kΩ resistor will slowly

charge the capacitor, eventually taking the anode of D3 to -12V. After this D3 will have no further effect.

This slow start circuit prevents the output voltage from rapidly increasing to full output when the mains is first switched on, before op amps IC2a & IC2d can gain control.

In the meantime the 4.7kΩ resistor will be trying to turn the output transistor on. When the output voltage reaches a level which results in pins 12 & 13 of IC2d being at almost the same potential the op amp will take control and hold the output at this level.

The negative supply control system works in a similar manner to that for the positive. In this case we start with another 18V secondary which is rectified using four 3A diodes (D13-D16) and filtered with two 4700µF capacitors to produce around 27VDC. This becomes DC2. The negative rail goes via the LOAD switch S2b to the negative output terminal on the front panel. The supply negative is routed via Q3 and the 0.1Ω resistor to ground.

Note that the negative voltage regulator uses an N-channel Mosfet which requires a positive voltage on its drain and a positive gate voltage to turn it on. Therefore all the diodes and supply voltages are reversed.

We would have preferred to use a Mosfet for Q2 as well, but P-channel IGFETs are still very expensive and are harder to obtain.

In other respects, the voltage and current control and soft start feature work in exactly the same way, via op amps IC1a and IC1b.

Because the analog-to-digital converter on the interface board can only operate with positive voltages, the negative output voltage is inverted by IC1c and scaled to 5 volts for full output by the 10kΩ resistor and the 2.2kΩ resistor in parallel with the 18kΩ resistor.

The resistors which are connected from the unused inputs of the operational amplifiers to ground are selected to reduce the input offsets.

## 12V supply

As the two supplies DC1 and DC2 are floating with respect to ground we need a separate ±12V supply to power the op amps. This is generated by IC3, transformer T1 and the associated components.

The 555 timer IC3 is wired as an astable oscillator running at about 27kHz and it drives transformer T1 via a .001µF capacitor. High-speed diodes D7 & D8 act as half-wave rectifiers to produce supply rails of ±12V. IC3 is supplied from the 15V 3-terminal regulator REG1 which provides a measure of regulation for the ±12V supplies.

The other 3-terminal regulator in the circuit is REG2, a 78L05 5V device. This provides the reference voltage for the positive and negative supply regulators.

REG2 feeds trimpot VR4 and then emitter follower Q1. This then feeds voltage control pot VR1, as well as the current limit pot, VR2.

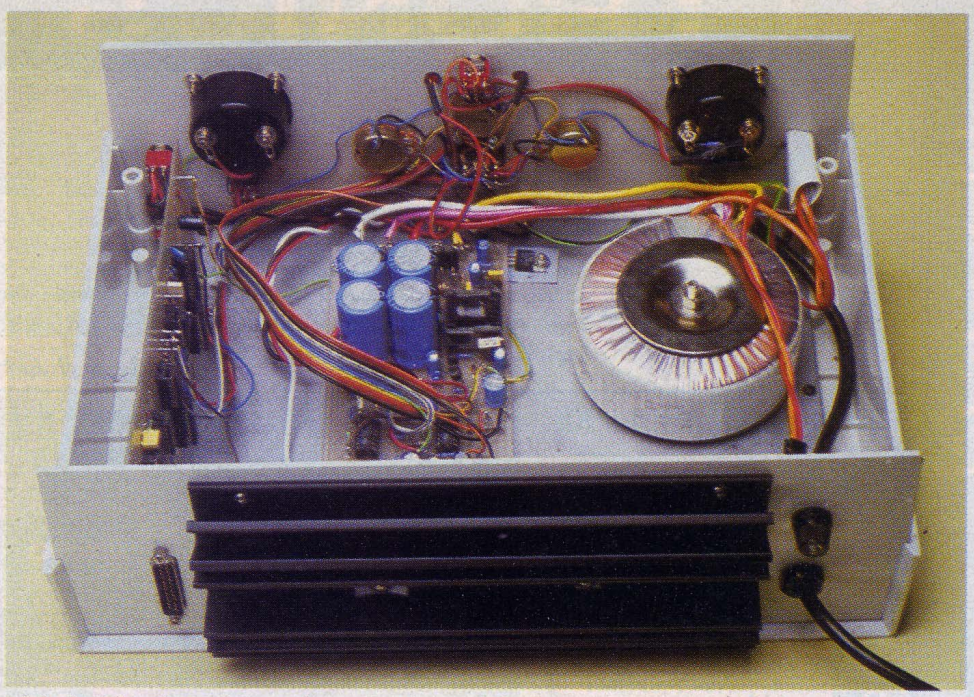
## Metering

The voltage and metering is fairly straightforward. Meter M2 is scaled from zero to 30V and monitors the output voltage between points TP7 and TP12. It is switched by toggle switch S5 to read the positive or negative output voltage.

To monitor current, meter M1 is used to monitor the voltage across the 0.1Ω emitter resistor for Q2 or the voltage across the 0.1Ω source resistor for Q3, depending on how it is switched by S4. The 1mA meter we used has an internal resistance of 58Ω. This has to be padded out to a total of 300Ω and this is the reason for the series 220Ω and 22Ω resistors.

## Current limit setting

When PB1 is pressed, meter M1 is switched to read the voltage at pin 14 of IC1d. This will be -5V for a current limit of 2.55A and because of the series 5.6kΩ resistor and the other series



**This inside view shows the prototype with the computer interface board (to be described next month) in place. Note that this board is optional; if you don't need computer control, leave it out and build the supply as described here.**

**This close-up view shows how power devices Q2 and Q3 are mounted on the heatsink (refer also to Fig.4).**

# ALTRONICS COMPONENTS

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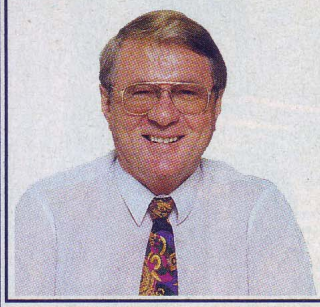

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**Regards, Jack O'Donnell, Managing Director**

Jack O'Donnell

## Pink Noise Generator Kit

NEW!

*Use it to accurately calibrate SPL measurements! A must for the audio engineer!*

**(See Jan '97)** Pink noise is used to calibrate audio systems to a particular sound level before they undergo frequency response checks eg. real time analysis, or just simply as a sound level calibration tone. Pink noise sounds like a roaring water fall, and contains a wide spectrum of audio frequencies. This kit has a 60mV output with a -60dB pad switch, and is connected to the audio system's power amplifier. Requires 9V battery (not included).

K 2592 **$24.95**

## Sound Level Meter Adaptor Kit

**(See SC Dec '96)** This kit is a useful instrument for measuring sound intensities from 20dB to 120dB, and is plugged into a standard digital multimeter. It features A, C, and unweighted (flat) response filters, with slow, fast and peak reaction times. An ideal piece of test equipment for the audio engineer or installer. Flat response from 28Hz to 50kHz (-3db). Powered by two 9V batteries (not included). The ideal companion to the K 2592 Pink Noise Generator, which can be used to accurately calibrate the sound system under test.

K 2590 **$55**

*Turn your DMM into an SPL Meter!*

## Hall Effect Current Probe Kit

*Plugs in series with the device under test and connects to your CRO's BNC input!*

**(See EA Nov '96)** Measuring high-potential currents can be fraught with danger, but this kit makes it safer, and has a better accuracy than most clamp-on meters or multimeters. Connected in series with the device under test eg. switchmode power supply, television etc., it allows the current to be observed on a CRO, and uses a Hall effect sensor to effectively isolate the oscilloscope from the line. Features: • Bandwidth DC to 25kHz • Current up to 10A • Negligible inductance & insertion loss • High slew rate (>30A/µs) • 400mV/Amp with ±1% accuracy. • Requires BNC-BNC patch lead to connect to CRO (P 0746)

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*Upgrade Your Mono Video with Stereo Effects!*

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M 9120 12V AC Plugpack to Suit $14.50

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This module is fully self contained, complete with pause/start key, on board microphone for direct recording, in built audio amplifier and playback button. The sound quality is great for static displays, alarms systems, monitoring systems. PA systems etc. Powered from an external 6V DC supply. Even if power is removed the message won't be lost.

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## Stereo Preamp Kit with Remote Volume

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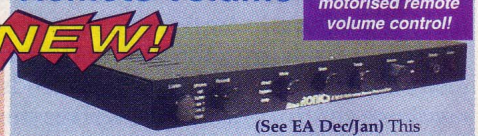

**(See EA Dec/Jan)** This impressive 6 input stereo preamplifier is an attractively priced addition to any hi-fi rack. Features: • Infra-red remote control volume • Power on mute • Bass, treble and mode controls • Dual input switching • Metal chassis CNC turret press punched and screened front and rear panels • Rack mountable with rack "ears" • Easy to construct with minimal wiring • Excellent S/N ratio and distortion figures. An optional RIAA phono preamp module is available if phono (turntable) inputs are required (K 5512).

K 5018 Stereo Preamp Kit **$269**

K 5512 Phono Preamp Kit $15.95

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*Includes LCD Digital Display for Precise Measurement!*

**(See SC Jan/Feb '94)** This 1.23 V to 40 V adjustable power supply is designed for heavy-duty work. With a hefty 3 ampere capacity, it uses a high efficiency switching regulator circuit. Features preset voltage and current limiting, full overload protection (with indicators) and an LCD panel meter for precise voltage and current readouts.

K 3330 Normally $239, NOW **$179**

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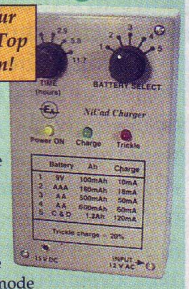
*Keeps Your Nicads in Top Condition!*



**(EA July '89)** Get 100's more recharge cycles from your nicads by charging them correctly. Here is a fully automatic NiCad battery charger that enables differing charge rates for AAA, AA, C, D or 9V cells. Once battery is charged, the unit switches to trickle charge until you switch it off. Requires 12V AC plug pack. **Features:** • Fully punched and screened case • Variable charge rate & timer • Visual display of charge mode

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## Universal Cable Checker Kit

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K 2569 Kit Version **$69**

Q 2590 Built and Tested Version **$139**

*Similar commercial units sell for more than $200! Build your own and SAVE HEAPS!*

## 10A Automatic Battery Charger Kit

**(See SC June '96)** This versatile battery charger can charge 6, 12, or 24V batteries at 10A continuous charge current. Features a sensing circuit to automatically determine what voltage battery is connected and a charge mode. Charging current is automatically switched from high to medium to trickle as the battery reaches full charge. It also has in-built short circuit and reverse polarity protection. Supplied with heavy duty battery leads with alligator clips, screened and punched front panel and case.

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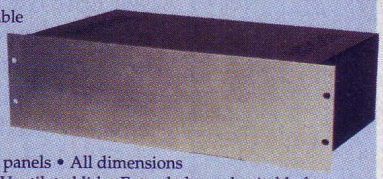

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These woofers are designed for effortless reproduction of hi-fi sound, and are ideally suited to 2- or 3-way speaker systems or component subwoofers in A/V, Hi-Fi or Car Audio systems. They feature low-Q, low resonance, high efficiency and poly emulsion coated paper cones with rubber surrounds.
*Exclusive to Altronics in Australia.*

**C 3024** 200mm Bass Driver
Pmax 100W, Fo 35Hz, SPL 91dB 1W/1m, Qts 0.25, Vas 48L
Normally $69, NOW **$49** SAVE 25%!

**C 3030** 300mm Bass Driver
Pmax 160W, Fo 25Hz, SPL 93dB 1W/1m, Qts 0.22, Vas 289L
Normally $169, NOW **$99** SAVE 40%!

WOW!

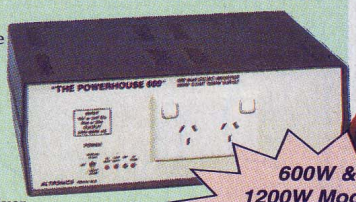
## Autoranging Digital Multimeter

Our previous autoranging DMM sold for $119, in our opinion this new model is far superior, and right now it's $40 cheaper!
*Features:* • 3.75 digit LCD with a digital bargraph display • autoranging with manual override • display hold function • audibly continuity buzzer • diode check • up to a huge 15A current measuring capacity • auto DC/AC detect with manual override • fuse protection • **supplied complete with a shock-proof rubber holster and flexible test leads!**
**Specifications:**
**DC Voltage:** 320mV, 3.2V, 32V, 320V, 600V
**AC Voltage:** 3.2V, 32V, 320V, 600V
**DC & AC Current:** 320µA, 3200µA, 32mA, 320mA, 15A
**Resistance:** 320Ω, 3.2k, 32k, 320k, 3.2M, 320M

***Fantastic Value!*** *3.75 digit DMM with bargraph and autoranging! Includes rubber holster and test leads!*

Q 1072 Normally $99, NOW **$79**

## The Powerhouse 300W, 600W & 1200W Inverters



The Powerhouse Inverters can provide 240VAC power from a heavy duty 12 or 24V battery. Using the latest MOSFET output stage and toroidal transformer these inverters are efficient and will deliver high surge currents. The Powerhouse series has been designed not only for rugged bullet proof operation but for ease of construction. They include a fully drilled, pre punched chassis complete with silk screened front panel. Suitable for use in camping, boating, fishing, mining, farming, & remote settlements

***600W & 1200W Models Feature Micro-Processor Control Circuitry!***

*The 600W and 1200W models now feature ultra-stable Motorola CPU-based control circuitry!*

| | |
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| K 6750 300W Kit Version 12V Input | $315 |
| K 6755 300W Built & Tested 12V Input<br>K 6756 300W Built & Tested 24V Input | $399 |
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| K 6777 600W Built & Tested 12V Input<br>K 6779 600W Built & Tested 24V Input | $699 |
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| K 6797 1200W Built & Tested 12V Input<br>K 6799 1200W Built & Tested 24V Input | $999 |

## 1GHz Frequency Counter

This multiple-function counter covers a range of 10Hz to 1GHz. It includes an eight digit, seven segment, LED display, low power consumption circuit design, small size, light weight, highly stabilised crystal oscillator for accurate measurement and full input signal conditioning. BNC input connectors.

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Q 1535 Normally $399.00
This Month Only **$299**

**Check out our Internet site for a list of major Altronics resellers across Australia! There's an Altronics stockist near YOU!**
***http://www.altronics.com.au***

## Piezo Buzzer

**Ideal for reversing alarms, warning panels, headlight reminder, etc.**

Can be configured to emit a continuous tone, or a pulsing beep at about 2Hz (at 12VDC). It's ideal for reversing buzzers, car alarm internal warning beepers, headlight warnings, alarm panels, timers etc. Rated at 95dB at 30cm, and is powered by 6 - 28V DC. Draws only 15mA at 24V. Dimensions 43Ø x 34Hmm.

S 6119 Normally $14.95 ea, NOW **$7** ea,
or Buy 4 for **$20**

## Central Door Locking Kit

**High Quality, Reliable *RHINO* Central Locking System**

All four doors will automatically lock or unlock with the operation of either of the front doors. Add the ease and convenience of central locking to your car. Can be interfaced to our S 5205 car alarm (and others) to lock or unlock all four doors when the alarm is remotely armed or disarmed. Kit includes everything you need to fit central power locking to your vehicle; module, solenoids, rods & couplers, grommets, punched strip, screws & clipnuts, even the wiring harness! The actuators are motorised with an inbuilt gearbox to ensure reliable and positive operation. One actuator is mounted inside each door. Includes central control unit which mounts under the car dash. For use with 12V negative earth systems.

*Interface it to the S 5205 Car Alarm and lock & unlock the doors by remote control!*

S 5241 Normally $119 ea, **This Month Only $89**

## Radio Mic Bargain

***HURRY!*** *Offer must end SOON, as stocks are strictly limited!*

**We have only a few of these bundled systems left, so be quick!** They are professional quality and are used in commercial installations across Australia. Ideal for DJs, nightclubs, churches, sporting and social clubs, function rooms and community halls. We don't normally offer them at reduced rates to our mail order or retail customers, but here they are at an INSANE price! Each system includes a complete receiver with antennae and audio lead and a hand held microphone transmitter.

202.4MHz System: C 8100 Receiver and C 8242 H/Held Transmitter
203.7MHz System: C 8105 Receiver and C 8244 H/Held Transmitter

All Systems **$379** ea **BARGAIN**

***Normally $705, SAVE OVER 45%!***


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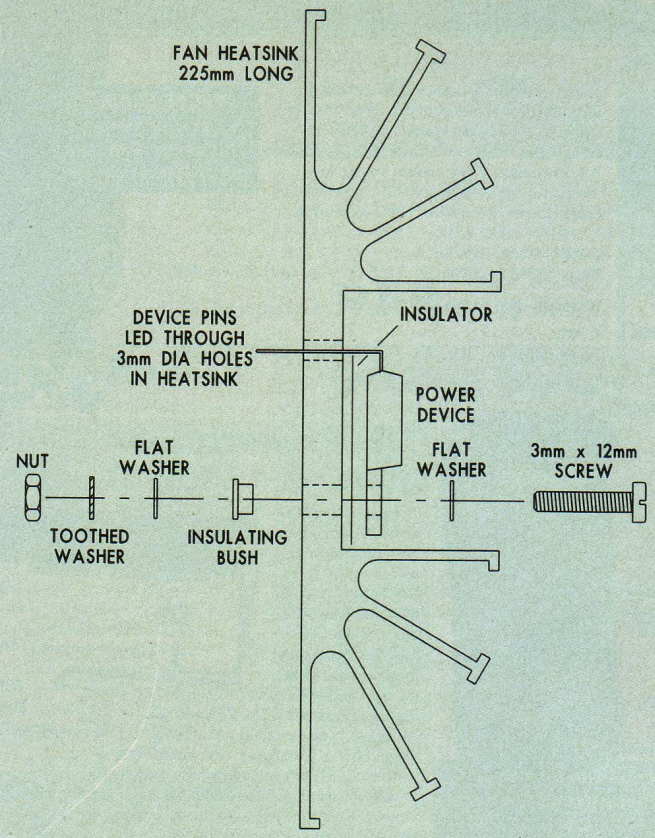



**Fig.4: mounting details of the transistors on the heatsink. After mounting, use your multimeter to confirm that the metal tabs of the devices are correctly isolated.**

resistances, the reading will be close to 2.55.

## Construction

Having described the power supply circuit we will now describe how you put it together, starting with the PC board. The first step is to check the board for open circuit tracks or shorts. The best way to do this is to hold it up to a bright light and look at the copper pattern from the fibreglass side. An open circuit track will stand out. After repairing any tracks or bridges, begin by fitting the four links and the 28 PC stakes.

The resistors, 1N914 diodes and IC sockets are inserted next. Double check the IC socket orientation and diode polarity. Use a multimeter to check the value of each resistor as it is installed.

The low profile capacitors and power diodes go in next. The power diodes should have a loop in both leads to allow for thermal expansion.

Next fit and solder in REG2 and Q1, the three trimpots and the four filter capacitors. T1, REG1, Q2 and Q3 are the last items to be fitted.

## Transformer winding

Before you finish the board you will need to wind the high frequency transformer T1. The three windings all use 0.25mm enamel copper wire. The plastic bobbin former for the transformer has the numbers 1 to 8 moulded on the top side. The primary winding starts on pin 4 and the wire is wound on in a *clockwise* direction and 75 turns later terminated on pin 1. Don't solder the leads yet. Just wrap them around the former pins using a few turns and leave 15-20mm free.

The secondary starts on pin 8 and consists of 145 turns wound *clockwise* (the same direction as the primary) and terminating on pin 7. Without breaking the wire, put a 30mm loop in it, twist it around pin 6, then wind on another 145 turns *in the same clockwise* direction and terminating on pin 5.

There is no magic in the clockwise direction but it is most important that the primary and secondaries are wound in the *same* direction. Slip the ferrite core halves into the former and see how the wires need to be dressed to clear the ferrite. Clean and tin each wire end, wind 2-3 turns around its pin and push the wire down the pin close to the base.

Check the ferrites for clearance again and when you are satisfied quickly solder each pin. Don't apply the heat for too long as the plastic boobin is very soft. Insert the ferrites in the former and wrap a layer or two of sticky tape around them to hold them together. Once the transformer is mounted on the PC board you can put a cable tie around it.

With the PC board completed, you can start work on the case. We used a steel baseplate to mount the power transformer and the PC board. It also functions as a heatsink for the 3-terminal regulator REG1.

Your first task with the case is to drill the steel baseplate, if you are not working from a kit. You will need holes for the transformer mounting bolt, the mounting screw for REG1 and the two mounting screws for the PC board.

Mount the power transformer, the PC board and REG1 to the steel baseplate before installing it in the case.

A large single sided finned heatsink is mounted on the rear panel for the two power transistors, Q2 and Q3. The rear panel will need to be drilled to take the heatsink and transistor mounting screws, the cordgrip grommet and fuseholder and the D socket for the interface board.

Similarly, the heatsink will need to be drilled for the mounting screws and with holes for the leads of the two power transistors. We drilled individual holes for the three leads of Q2 and a single 10mm hole for the leads of Q3.

Both transistors must be mounted with either a mica washer, insulating bush and heatsink compound (see Fig.4) or one of the new thermal washers and an insulating bush. In either case, do not overtighten the mounting screws.

## Front panel assembly

Fit the Dynamark adhesive label to the front panel and then you can drill all the holes for the front panel hardware. The meters will be supplied with their own template as an aid to

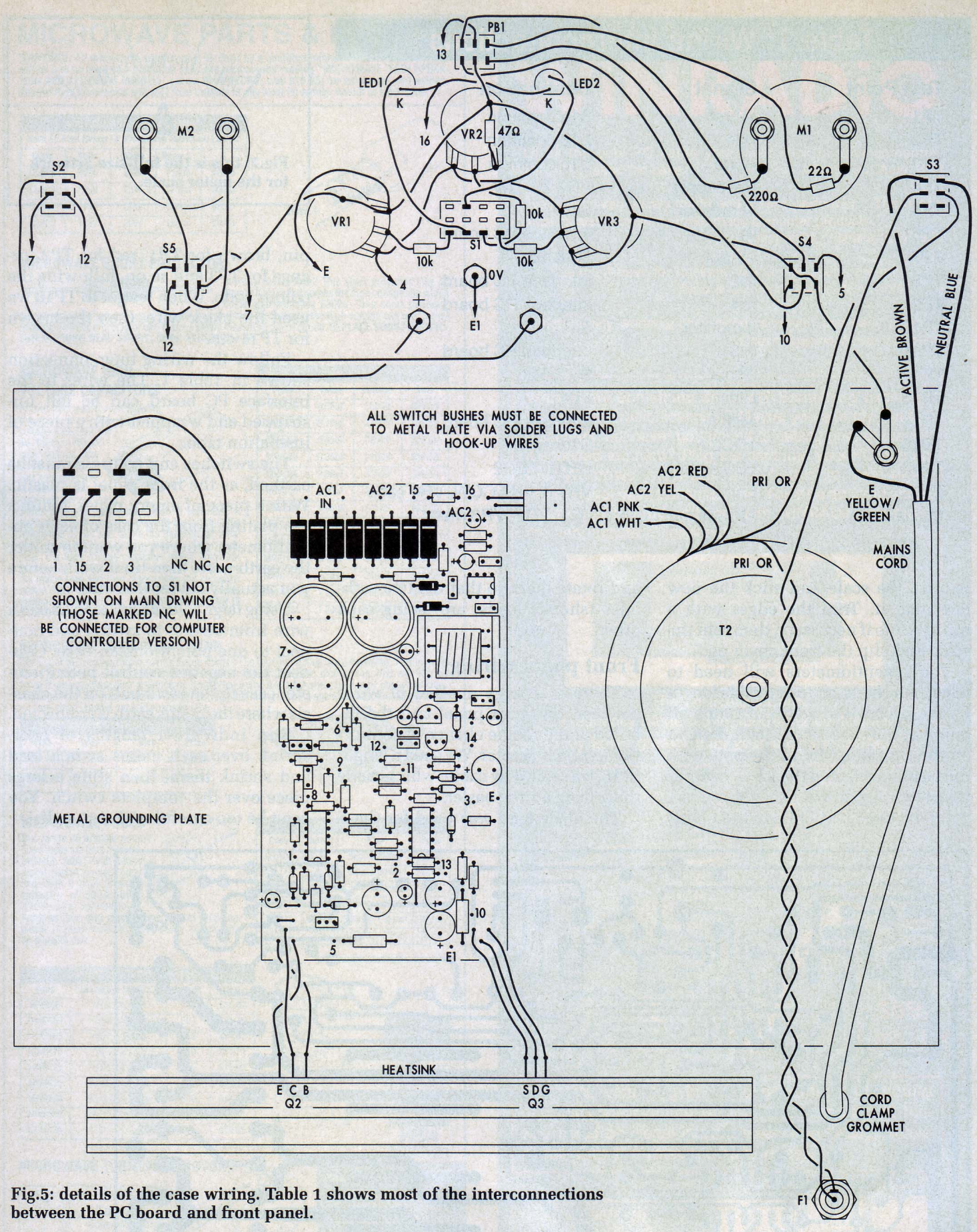



**Fig.5: details of the case wiring. Table 1 shows most of the interconnections between the PC board and front panel.**

cutting the circular holes.

Mount all the switches and meters. You will need to fit a new scale to the ammeter and this is more easily done after the meter is mounted on the front panel. When the time comes, unclip the front cover of the ammeter and remove the two tiny Phillips head screws from the meter scale. Carefully

## Table 1: Wiring Interconnections

| Test Point | Signal | Destination |
|---|---|---|
| TP1 | +V ref | S1a common |
| TP2 | I ref | S1b common |
| TP3 | -V ref | S1c common |
| TP4 | Ref supply | VR1,2,3 CW |
| TP5 | +I monitor | S4 |
| TP6 | IN1 | Interface PC board |
| TP7 | +V out | S5 & S2a |
| TP8 | IN2 | Interface PC board |
| TP9 | IN4 | Interface PC board |
| TP10 | -I monitor | S4 |
| TP11 | IN3 | Interface PC board |
| TP12 | -V out | S5 & S2b |
| TP13 | I limit | PB1 |
| TP14 | +5.6V | Interface PC board |
| TP15 | +DC2 | S1d |
| TP16 | LED supply | LED1, LED2 |
| E | Earth | VR1 & VR3 CCW, VR1 case |
| Mains Earth | All switch actuators, VR1, VR2, VR3 metal | |

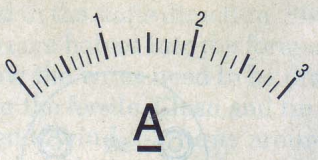



**Fig.7: this is the full-size artwork for the meter scale.**

remove the scale and stick the new one onto it. Trim the edges with a utility knife if necessary, then refit the scale and clip the front cover on.

The potentiometers will need to have their shafts cut to a suitable length for the knobs. We had to cut 10mm off ours but the shaft length will depend on the supplier. Mount the pots with the terminals facing the local/computer switch, as shown in Fig.5.

Fit the two 5mm LEDs in their clips and rotate them so that the two cathodes (shorter leads) are facing each other.

### Front panel wiring

There is a large number of wires between the front panel and the PC board and thus the chance of connection errors is greater. We used a length of 16-way rainbow cable, which made the wiring a little easier.

The black lead was used for the E pin, brown for TP1, red for TP2, orange for TP3 and so on, following the colour code. When we got to TP10 we used the black wire, then the brown for TP11 etc.

Follow the wiring interconnection shown in Table 1. The wires to the interface PC board can be left unstripped and wrapped with a piece of insulation tape.

The switches and controls must be earthed, as the front panel is plastic. With a piece of emery paper, remove the plating from the case of each potentiometer where you want to solder the earth wire, then tin it well, before you actually solder the wire.

Using large solder lugs, loop an earth wire from switch to switch and connect to one potentiometer case. Connect the negative control potentiometer case to the earth bolt on the chassis where the mains earth is connected.

Slip individual lengths of heatshrink over each mains switch lead and shrink them, then slide a large piece over the complete switch. You can't be too careful with 240 volts!

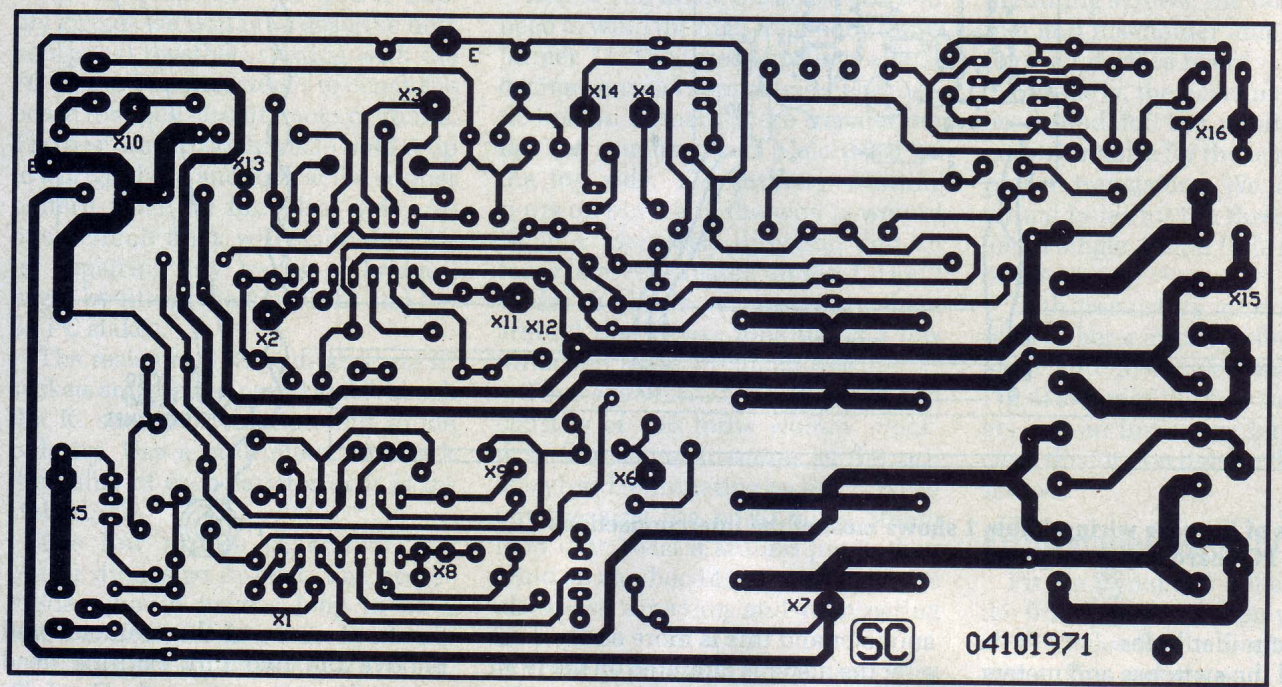



**Fig.6: the full size etching pattern for the PC board.**

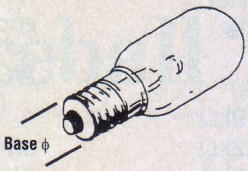
# MICROWAVE PARTS & REPAIRS

**WARNING!: All microwave repairs must be done by a qualified microwave technician. All text within is to be used as a guideline only. We recommend reading "MICROWAVE OVEN OPERATION AND SERVICING MANUAL" (code: MAN-MICRO, cost $19.95) for full safety instructions. Shailer Park Electronics will NOT take liability in any form for safety, health or work done.**

**MICROWAVE OVEN LAMPS**

**Hard To Find Range Of Microwave Resistant Lamps**

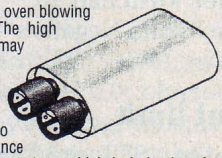
| Code | Volts | Watts | Base ϕ | $ |
|---|---|---|---|---|
| CL818 | 240V | 25W | 13mm | $8.50 |
| CL819 | 125V | 25W | 13mm | $9.50 |
| CL821 | 240V | 20W | 15mm | $8.50 |
| CL822 | 125V | 20W | 15mm | $9.50 |




## MICROWAVE SHORT PROTECTOR

Blowing mains fuse? This short protector may be blown. It's located across the high voltage cap which holds approximately 2300V. This short protector can be tested by first unplugging mains lead and then discharging the high voltage cap with a 1kΩ resistor. The short protector can then be safely measured out of circuit. **REPLACE SHORT PROTECTOR IF FOUND DEAD SHORT. Code: 2X062H $14.95**

## MICROWAVE HIGH VOLTAGE CAPACITORS



Is your microwave oven blowing the main fuse? The high voltage capacitor may be faulty. These high voltage, low tolerance capacitors are used in microwave ovens to complete a resonance circuit with the magnetron which is inductive. A faulty capacitor may upset the lead-lag factor of the resonance circuit and cause the transformer to labour (hum) or blow short protector and/or main fuse. The high voltage capacitor, which holds approximately 2300V, can be tested by unplugging the mains lead and then discharging the capacitor with a 1kΩ resistor, after which it can be safely measured out of circuit. **REPLACE CAPACITOR IF FOUND FAULTY OR DEAD SHORT**

**MICROWAVE HIGH VOLTAGE CAPACITORS**

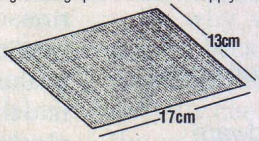
| Code | Value | Voltage | Cost |
|---|---|---|---|
| MWC65 | 0.65uF | 2300V | $35.50 |
| MWC70 | 0.70uF | 2300V | $36.50 |
| MWC83 | 0.83uF | 2300V | $39.50 |
| MWC85 | 0.85uF | 2100V | $36.50 |
| MWC86 | 0.86uF | 2100V | $39.50 |
| MWC90 | 0.90uF | 2100V | $39.50 |
| MWC95 | 0.95uF | 2100V | $39.50 |
| MWC100 | 1.00uF | 2100V | $50.50 |
| MWC105 | 1.05uF | 2100V | $42.50 |
| MWC110 | 1.10uF | 2100V | $44.95 |
| MWC113 | 1.13uF | 2100V | $45.50 |
| MWC114-6 | 1.14uF | 2100V | $44.95 |
| MWC120 | 1.20uF | 2100V | $44.95 |

## MICROWAVE OVEN ROOF LINING

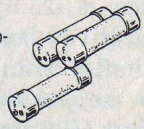
Does your microwave throw sparks inside cavity? The roof lining may need replacing. This lining is made of a special material to diffuse the microwave beam for even distribution. You will find the lining if you open the door and look up inside the cavity; it is a flat sheet held in by screws or clips. With age, the microwave beam will burn through this lining causing sparks inside. We supply 13cm x 17cm sheet, simply cut and shape to size.

**MICROWAVE OVEN ROOF LINING**

| Code | Type | Size | Price |
|---|---|---|---|
| MRL20 | Microwave | 13cm x 17cm | $15.50 |
| MRL50 | Convection Microwave | 13cm x 17cm | $17.95 |




## MICROWAVE FUSES



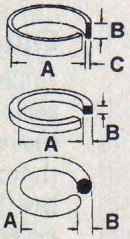
Our range of original microwave fuses are time delayed, ceramic tube, with brass nickel plated contact cups and have a high breaking capacity of 500A/500V. Never use conventional fuses as they may explode and shatter throwing pieces of glass inside the food cavity, which may be a health risk.

**MICROWAVE FUSES**

| Code | Rating | Size | Price |
|---|---|---|---|
| AF010P | 6.3A | 5mm x 20mm | $2.50 |
| AF011P | 8A | 5mm x 20mm | $2.50 |
| AF012P | 10A | 5mm x 20mm | $2.50 |
| AF019L | 6.3A | 6.35mm x 32mm | $2.50 |
| AF020L | 8A | 6.35mm x 32mm | $2.50 |
| AF021L | 10A | 6.35mm x 32mm | $2.50 |

**MICROWAVE TURNTABLE BELTS**

| Code | Dimensions (A x B x C) | Length | Cost |
|---|---|---|---|
| MWB95 | 95 x 7.0 x 0.6 | 300 | $11.65 |
| MWB100 | 100 x 7.5 x 0.6 | 320 | $11.70 |
| MWB105 | 105 x 4.0 x 1.0 | 330 | $11.80 |
| MWB110 | 110 x 7.0 x 0.6 | 340 | $11.70 |
| MWB165 | 116 x 4.0 x 1.0 | 520 | $15.65 |
| MWB210 | 210 x 2.5 square | 650 | $14.95 |
| MWB260 | 260 x 3.0 square | 800 | $14.90 |
| MWB280 | 280 x 3.0 square | 880 | $13.30 |
| MWB175 | 175 x 2.5 round | 550 | $19.95 |

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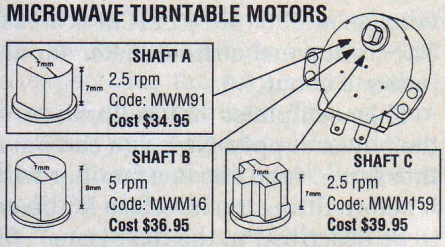

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Want to try something different? Something exciting? Heard about radio scanning? Maybe you already wanted a scanner, but never got around to getting one, or maybe it sounded too hard? Plug the card into your PC, fire up the Windows software and listen to real-time, professional radio transmissions. You'll be amazed about what's going on around you: with WiNRADiO, be there the very minute it happens!

The WiNRADiO Card.
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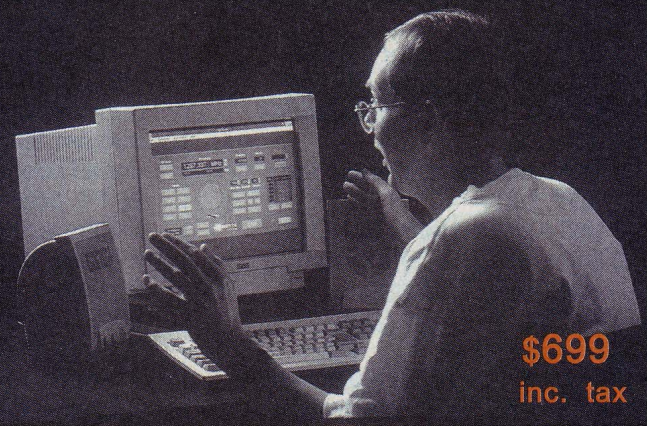
(Sixty times greater than your ordinary car radio.)



**$699 inc. tax**

Warning: Listening in to police radio and mobile phones and/or acting on information obtained this way could be illegal in your state. If in doubt, please check with the relevant authorities.

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web: www.winradio.net.au

R&D Award Winner Philadelphia 1996

COOL ★★★★★

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1 PC board, code 04101971, 160 x 83mm
1 instrument case, 355 x 250 x 122mm, Altronics H-0490 or equivalent
1 baseplate, Altronics H0492 or equivalent
1 front panel label, 345 x 118mm
1 160VA toroidal mains transformer with two 18V secondaries (T2)
1 1mA 30V scale, panel meter, 58 x 52mm (M2),
1 1mA 58Ω, panel meter, 58 x 52mm (M1)
1 0-3A meter scale
1 4PDT miniature toggle switches (S1)
4 DPDT flat shaft miniature toggle switches (S2-S5)
1 3-core mains lead with moulded 3-pin plug
1 2AG panel fuseholder
1 1A 2AG slow-blow fuse
3 16mm aluminium knobs
1 red binding post
1 black binding post
1 green binding post

**Semiconductors**
2 LM324 op amps (IC1, IC2)
1 555 timer (IC3)
1 BC338 NPN transistor (Q1)
1 BDV64B PNP Darlington transistor (Q2)
1 MTP75N06 N-channel Mosfet (Q3)
1 7815 15V regulator (REG1)
1 78L05 5V regulator (REG2)
6 1N914, 1N4148 signal diodes (D1-D6)
2 1N4936 fast rectifier diodes (D7, D8)
8 1N5404 3A diodes (D9-D16)
2 5mm red LEDs and mounting clips (LED1, LED2)

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2 470µF 25VW PC electrolytic
5 100µF 25VW PC electrolytic
2 47µF 50VW PC electrolytic
2 10µF 50VW PC electrolytic
5 0.1µF MKT polyester
1 .01µF MKT polyester
1 .0022µF MKT polyester
2 .001µF MKT polyester

**Resistors** (0.25W, 1%)

| | |
|---|---|
| 2 91kΩ | 1 3.9kΩ |
| 1 51kΩ | 1 2.2kΩ |
| 1 22kΩ | 2 1.5kΩ |
| 4 18kΩ | 2 1.2kΩ |
| 2 10kΩ 1W 5% | 3 510Ω |
| 11 10kΩ | 1 470Ω |
| 1 8.2kΩ | 1 220Ω |
| 1 5.6kΩ | 1 82Ω |
| 1 5.1kΩ | 1 47Ω |
| 5 4.7kΩ | 1 22Ω |
| 1 4.3kΩ | 2 0.1Ω 2W 5% |

**Potentiometers**
2 10kΩ 24mm linear potentiometers (VR1, VR3)
1 10kΩ 24mm log potentiometer (VR2)
1 2kΩ 25-turn top adjust trimpot (VR4), Altronics R-2378 or equivalent
1 100Ω 25-turn top adjust trimpot (VR5), Altronics R-2370 or equivalent
1 1kΩ 25-turn top adjust trimpot (VR6), Altronics R-2376 or equivalent

**Miscellaneous**
1 cordgrip grommet to suit mains cable
2 TO-220 mounting hardware
1 TO-3P mounting hardware
300mm 20-way rainbow cable
500mm 20-way rainbow cable
500mm 16-way rainbow cable
tinned copper wire
28 PC board stakes
5 6.5mm lugs
2 solder lugs
2 100mm cable ties
50mm 3mm heatshrink
100mm 16mm heatshrink
7 3mm x 10mm machine screws
2 3mm x 15mm machine screws
1 3mm x 20mm machine screw
12 3mm hex nuts
11 3mm flat washers
10 3mm spring washers

Similarly with the fuseholder, sleeve each connection then sleeve the complete holder.

## Testing

Before you turn on the power use your multimeter to test for continuity from TP1 through to TP16 on the PC board to the destination of the other end of the wire (see Table 1).

Turn the front panel switch off, plug the lead into a mains outlet and turn it on. Switch the front panel mains switch on and watch for smoke or meters against the stop and listen for buzzing noises. If it passes the smoke test (no smoke), things are looking good.

## DC voltages

You should measure about 27V DC on each of the 10kΩ resistors near the filter capacitors. The voltage from D7's cathode to ground should be around +12V to +12.5V, while D8's anode should be around -12.5V to -13V.

With the voltmeter switch set to + volts, the meter should follow the rotation of the "Volts Positive" knob. A similar situation should occur with the meter switched to "- volts" and with the "Volts Negative" knob being rotated.

## Current limit

Turn the "SET mA" control anticlockwise, then quickly press and release the current limit pushbutton. If the meter didn't move hold the button down and rotate the control clockwise. The meter should move up the scale to around 25.

If everything is fine up to this point, you are on the home straight. All you have to do now is the final calibration.

With a digital multimeter connected to the negative output terminals, rotate the "Volts Negative" control fully clockwise. Adjust VR4 until the output voltage is -25.5V. Next, turn the "Volts Positive" control fully clockwise and after connecting the multimeter to the positive output terminals, adjust VR6 until the output is +25.5V. Note: the negative output voltage must be set before the positive adjustment is carried out.

## Output current

Connect a 2.2Ω 10 watt resistor in series with a multimeter that is capable of reading 2A DC and connect them across the positive terminals of the power supply. Set the positive voltage so that 2A is flowing through the resistor. Adjust VR5 so that the voltage on TP8 (pin 8 of IC2) is 3.92V. The front panel current meter should indicate about 2.0.

This completes the calibration of the power supply. Now you can put it into service and become familiar with it before fitting the interface PC board to be described in the next issue. SC

# SERVICEMAN'S LOG

# The fireball TV set from hell

**It might seem over-dramatic to describe a rather ordinary looking NEC 51cm TV set like this but this was indeed a wolf in sheep's clothing. And it lead me on a merry chase to discover the cause of the problem.**

The set, an NEC N4840 using a Korean Daewoo C-50 chassis, was brought in by a young, brusque woman who was succinct and to the point: "it smoked, burned and then went black". I barely got her name and address before she left as quickly as she had arrived.

I was rather busy at the time and a couple of days passed before I was able to examine the set. It didn't seem wise to switch the set on immediately, as her description of the fault suggested that there may have been a fire. As such, it would be all too easy to exacerbate the problem and, in any case, there would probably be obvious visual evidence of the damage inside.

And so it was that I gingerly removed the back, carefully examined the various circuit boards, and tried sniffing for the telltale smell of fire. But there was nothing. The set, which I guessed was about seven years old, was reasonably clean and everything look OK. I especially examined the flyback transformer and power supply circuitry but all was fine. Perhaps the damage was on the inside of the deflection yoke but that would have to wait for the moment.

Eventually, I concluded that there was nothing for it but to go for a smoke test – in this case, literally. I plugged the set into the power and switched it on. At this stage, I didn't know what to expect but the result was something of an anticlimax. The set momentarily spluttered into life and then died – no sign of smoke or flames or anything dramatic yet.

OK, so where to start? My first voltage check was at the collector of the line output transistor. This measured 103V which seemed reasonable and so I switched the set off and fished out the file on NEC/Daewoo sets. Unfortunately, the only circuit diagram I had was an abysmal photocopy with virtually illegible component values and type numbers. However, by using a magnifying glass, I could just discern that the B+ rail was indeed 103V which meant that the power supply was probably OK.

So why was the set dead? Well, maybe because a safety circuit had turned off the horizontal oscillator. I initially confirmed this by measuring the collector voltage of the driver transistor in this stage – it was floating at the B+ potential, which meant that it wasn't turning on and off. What's more, a quick check with the CRO showed that there was no waveform on pin 20 of IC I501 (TA8718).

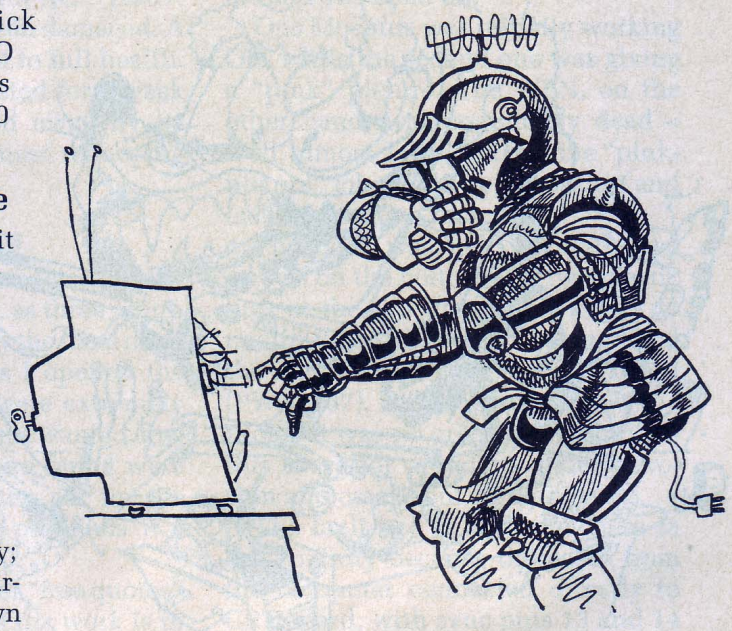
## Tricks of the trade

Because the circuit diagram was so poor, I could not discern how the protection circuit worked or even where it was. Basically, there were two possibilities to consider: (1) either the protection circuit itself was faulty; or (2) the protection circuit was shutting down the horizontal oscillator in response to a voltage that was going too high.

To test the latter theory, I decided to try using a Variac to reduce the mains voltage before switching the set on. Of course, the input voltage can only be reduced so far. The set is remote controlled and if the input voltage is set too low, the microprocessor is starved of voltage and will not switch the set on.

Nevertheless, I ploughed on and swung the input voltage up to 110V AC. Before switching on though, it is necessary to secure the PC board. Normally, this is held into the front of the cabinet shell by pressure from the back. As a result, if you try to switch the set on without the back in place, the pressure on the mains switch can be enough to push the whole chassis back inside the cabinet without the power actually coming on.

To overcome this problem, I held the rear of the chassis and the very edge of the PC board with one hand, taking extreme care not to touch any of the parts or copper tracks. By this stage, I was really beginning to feel relaxed about the repair and that the



symptoms had been over exaggerated. I was wrong.

When I pressed the power switch, the set powered up . . . and up . . . and up, until there was a terrific "crack". I jumped away, partly in response to this "crack" but mostly due to an electric shock that I received from the two places I had been touching the set. And it continued to crack and spark until I recovered my senses sufficiently to dive for the mains wall power socket and switch it off.

It would hardly be an exaggeration to say that we had too much voltage!

Now I was going to have to be much more cautious. Obviously the EHT was far too high and it was arcing everywhere – even across the plastic insulation and onto me. The shock wasn't severe, except perhaps to my wounded pride.

## EHT checks

After a fright like that, it was time for some heavy-duty armour. After checking that the .0056µF high-voltage capacitor across the line output transistor was OK, I reached for the EHT meter and connected it to the EHT output lead at the ultor cap (ie, where it plugs into the tube). I also connected the multimeter to the B+ rail so that I could monitor this voltage as well.

There was no way I was going to touch the PC board again. This time I wedged the chassis into the front of the cabinet with an old defection yoke rubber positioner and turned the variac down 100V.

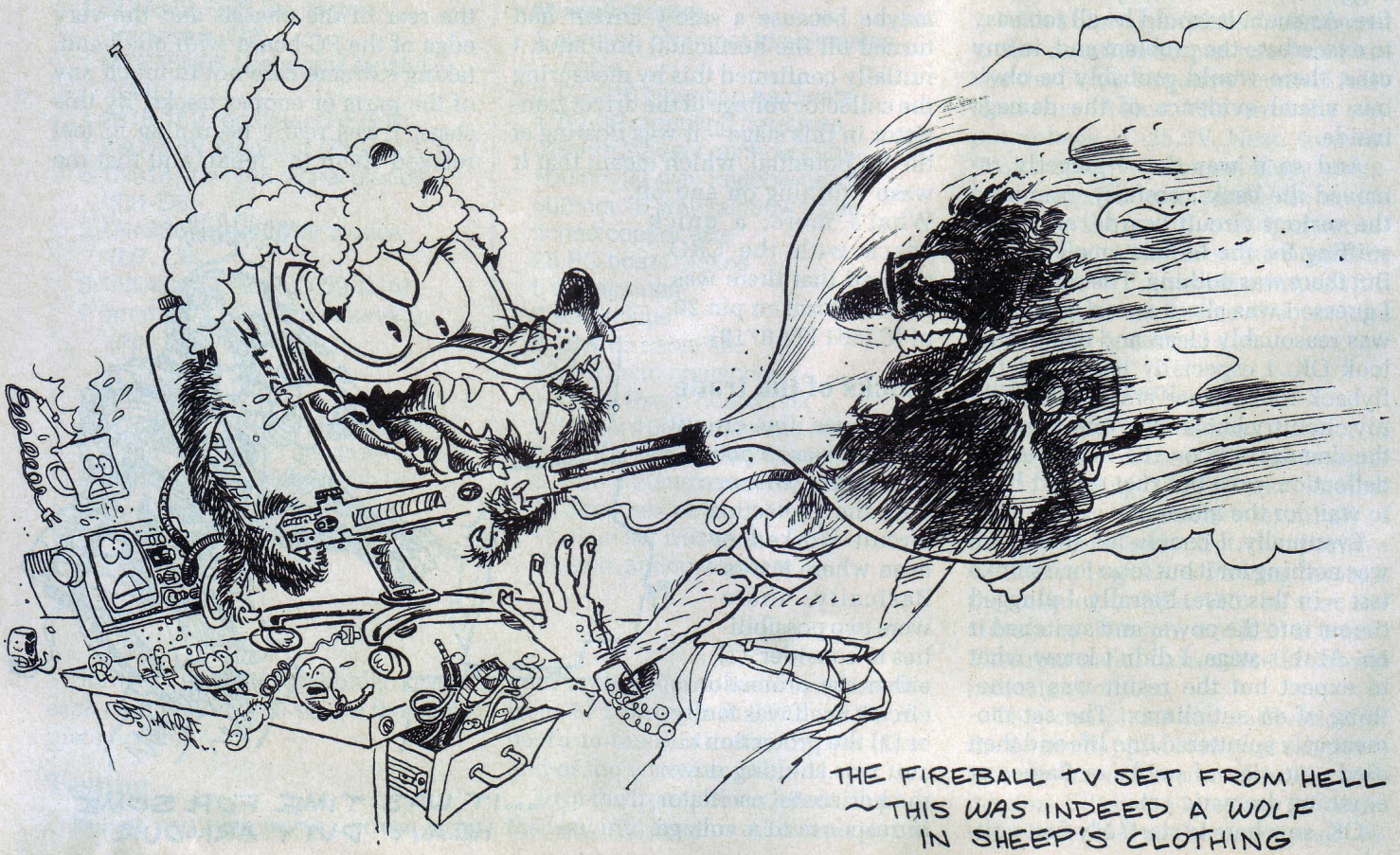
Wearing a rubber glove, I switched the set on and watched the meters. Interestingly, the multimeter showed that the B+ rail initially rose to +103V for a second or so and then continued to rise even higher to over 200V (fsd on the meter). Similarly, the EHT paused momentarily at about 22kV and then rose to over 30kV, at which point it began to arc everywhere and I had to switch off.

I was confused. Why was the B+ rail OK in shutdown mode and why was it rising so high until shutdown occurred? Right now, I didn't have any answers to these questions but there was one other worry; all this arcing was bound to cause more damage to peripheral circuits.

To overcome this problem, I decided to disable the line output stage until I had sorted out the problem with the B+ rail. Fortunately, this is easy to do; all that's required is a jumper between base and emitter of the line output transistor. This done, I switched the set on again and to my surprise the B+ rail rose to its correct value of +103V and stayed there dead steady.

By now I was really baffled. The only theory I could come up with at this stage was that the power supply was somehow breaking down under load. To this end, I replaced switchmode IC I801 (STR50103) and resistor R806 (470kΩ) as I had had problems with that going high in other sets. I also replaced C814 (1µF 160V) as it looked suspicious and connected another meter across the output of the bridge rectifier.

Unfortunately, that didn't cure it. When I removed the shorting jumper from the base of the line output transistor and switched on again, sparks flew everywhere. Reducing the variac below about 90V killed the set completely, while between 110V and 240V the voltage across the bridge rectifier



THE FIREBALL TV SET FROM HELL
~THIS WAS INDEED A WOLF
IN SHEEP'S CLOTHING

rose to 350V. And, as before, the B+ rail and the EHT rose well above their specifications and the set often closed down.

I did manage to reduce the arcing a little by cleaning around the ultor cap with CRC 2-26 and by cleaning around the CRT board but it was still very hairy. But obviously, this was fiddling at the edges and had nothing to do with the real fault.

## The EHT stage

My next approach was to replace the spike suppression capacitors around the line output transistor but this only showed that I was still miles off the track. About all I could do was temporarily fit some larger values to reduce the EHT to a more manageable 27kV while I checked the components around the flyback transformer.

Eventually, it got to the point where I began suspecting the transformer itself. Perhaps an internal insulation breakdown was causing EHT to arc onto the B+ rail? It certainly seemed that way, although the CRO only showed oversize (but otherwise perfect) pulses on the collector of the line output transistor. Nevertheless, I felt sure that I was on the right track at last and ordered a new transformer.

When it duly arrived, I wasted no time in fitting it. Unfortunately, it made absolutely no difference. I subsequently fitted a substitute yoke without result and, by this stage, was becoming thoroughly fed up. So much for my initial confidence.

## Logical thought

It was time for some logical thought. The crux of the problem was what caused the B+ rail to go high? It was time to take a closer look at how this rail is derived and where it went.

In summary, the B+ rail is generated from a switchmode power supply based on transformer T802 and switching IC I801. And pin 4 of I801 is connected via a diode to pin 2 of the flyback transformer (T402). I did some voltage checks and noticed that the B+ voltage got higher as it got closer to the flyback transformer – even on the same track!

How was this possible? By now, I felt sure that some sort of weird voltage doubling process was taking place and if it wasn't the diode itself that was at fault it had to be a capacitor. So I began hanging extra capacitors onto the B+ rail at different points in the hope of changing something but to no avail.

I was about to give up when I noticed that the circuit shows an electrolytic capacitor (22µF 160V) between pin 4 of the flyback transformer and earth. But what really caught my attention was that no internal connection to pin 4 was shown. Obviously, this was wrong – pin 4 had to go somewhere, otherwise why connect a capacitor to it?

Fortunately, the circuit of an NEC N4845 circuit (Daewoo C-900 chassis) is similar in many respects and this showed that pin 4 connects to a tapping on the flyback transformer primary. I removed the capacitor and immediately noticed that it was leaking slightly down the positive lead.

Could this be it, at last? I was desperate. I soldered in a new capacitor, held my breath and switched on. Hallelujah – it worked! The B+ rail stabilised at +103V and the EHT settled at 22kV, even with 240V input.

Unfortunately, all that EHT arcing had created a couple of extra faults, although these proved easy to track down. First, the picture came up as an overbright raster. This was due to the 10µF 160V electrolytic capacitor on the +180V rail to the RGB outputs. It had gone leaky and pulled the rail down to about 70V (the poor beast had nearly exploded from its trauma).

Secondly, the set suffered top vertical foldover and there were obvious retrace lines. This problem was traced to the vertical output IC (I301, AN5515) which had been damaged. A new IC restored the set to full health.

The set was soak tested for a week before it was whisked away by its unknowing owner. I must renew my life insurance.

## Computer monitors

The next day started looking distinctly "computerish", as three monitors were dropped in by the local computer shop as soon as I opened the door. As usual, they were extremely urgent and their clients wanted free quotes. To cap it off, no faults were specified which is often par for the course but can cause problems if a fault is intermittent.

I don't really consider "free quotes" as being fair as most of the work is in the diagnosis and not the actual fixing. After all, if you go to a doctor, he

charges you for the consultation, gives you no guarantee and then you have to go elsewhere to buy your own parts (drugs). In the circumstances, the best I can offer are free guesses.

Now that I repair so many monitors, I have set up two old 286 computers with VGA cards running a test program by Koenig, as well as a 386 with Windows 3.11 running a program called Wintach. I also have another 286 with an EGA card for older monitors.

The three monitors were all only two years old and were 15-inch digital non-interlaced SVGA types. Two were Moebius CM15VDE models and the other a WEN JD156B. I began by connecting them to my three computers and switched on.

One Moebius was initially working OK, while the second one was giving a "pink" picture. The WEN, on the other hand, was completely dead – well, almost. I decided that the "pink-picture" job would be the easiest and tackled that one first.

The back was held on with two screws on the bottom and two plastic lugs at the top that are awkward to unclip. Once this was off, I unsoldered the metal screen over the CRT board (PWB1787). It was obvious that the problem was no green so I examined this board for dry joints, glue, corrosion and cracks but all was OK.

The fault had to be somewhere in this vicinity because the cable from the computer connected directly to CRT board, with sync pins 13 and 14 going off to the motherboard.

Next, I considered the possibility

that the fault was in the cable itself. With this in mind, the DB25M plug was carefully examined for broken or bent pins, with particular emphasis on pin 2 (the green input). I could find nothing wrong. I then checked for continuity between pin 2 and the CRT board plug (P502) at pin 3 and again all was OK.

## Voltage checks

My next step was to make some voltage checks around the CRT board. First, I checked the voltage on the green cathode (pin 6 of the CRT socket), then the red and blue cathode voltages (pins 8 & 11). The latter both measured about 70V, whereas the green cathode voltage was at 60V. This was rather puzzling – I had expected the green cathode voltage to be higher than the other two, because the green gun was being cut off.

Because these voltages were not unreasonable (after allowing for grey-scale adjustments), and because there were no signs of any distressed components around the LM2419T RGB power amplifier IC, I concluded that the problem was back around the decoder IC (I501, MM1203). It was time to fire up the CRO.

Immediately, it was obvious that there was no signal on the green channel. There was no sign of a signal at the input to the decoder IC or even where the plug connects to the CRT board. There just had to be a short somewhere that was pulling the green signal down. To test this theory, I shorted the red input to the green one and the red immediately dropped out. Similarly, when the blue input was shorted to the green input, the blue dropped out.

An ohmmeter test between the green cathode and ground subsequently confirmed the existence of a short. All I had to do now was track it down.

I began my search by checking all the decoupling components to the green input but they were all OK. However, when I unplugged the connector to the CRT board, the short on the board vanished. Obviously, the problem was either in the cable or in the DB25M plug.

I suspected the plug at first as this is often abused. Unfortunately, it is directly moulded to the cable and wiggling it while checking between pins 2 & 7 with an ohmmeter made no difference – the two pins remained shorted.

Adjacent to the DB25M plug is a cylindrical assembly – probably a ferrite ring core – then there is a metre of cable before it goes through a plastic clamp on the back of the monitor. After that, about 15cm further on, there is an earth clamp around the striped cable braid, then another ferrite core before the plug to the CRT board. It all looked OK and nothing I could do would clear the short.

Getting a replacement cable probably wouldn't be easy, so I tried one last gamble – I connected a variable power supply across pins 2 and 7 and wound it up in the hope it might burn off the short. It didn't work; the current rose to 5A (the supply limit) with no sign of the short melting. But what was interesting was that the cable became warm only as far as the entry clamp but no further.

That just had to be the location of the short. I removed the cable, ringbarked the outer sheath on either side of the clamp marks and carefully opened the braid. To cut a long story short, I eventually found a small nick in the green signal cable which allowed the inner conductor to short against the outer braid.

After that, it was a simple job to correct the fault and refit the cable. And that fixed the problem – the green was fully restored and the display returned to normal.

## Two to go

By this time, Moebius No.2 had decided to show its fault which was a very dark display. On the bench, the tube filament read only 2V instead of 6.3V RMS, so all I had to do was find out why.

I traced the source of the voltage to the +6.3V rail off the main chopper transformer and it measured OK all the way from there to a plug designated P501a-1. From there, it went to P001-2 on a small "power saving" board and then from P001-1 to the CRT socket board. And the 4V was being lost on the power saving board.

The power saving circuit includes transistor Q003 (2SD667). The 6.3V rail goes to its collector and the output to the picture tube filaments. The base

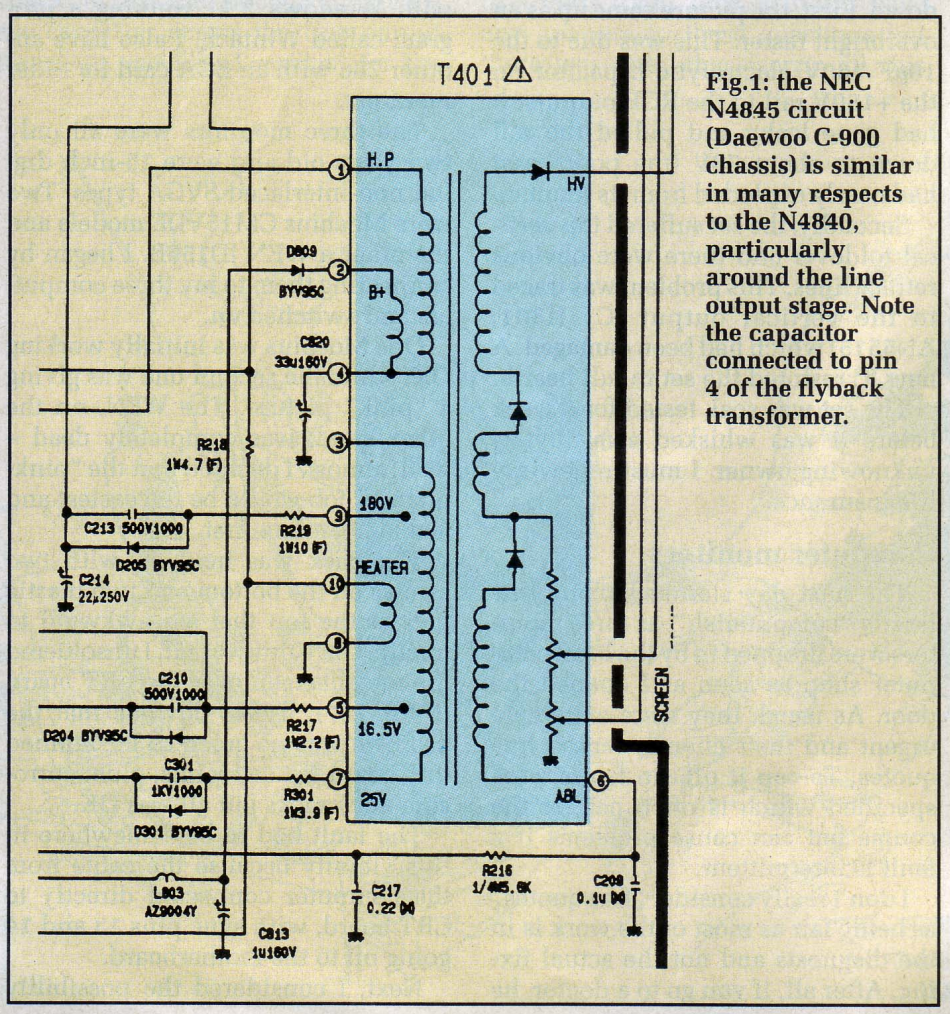
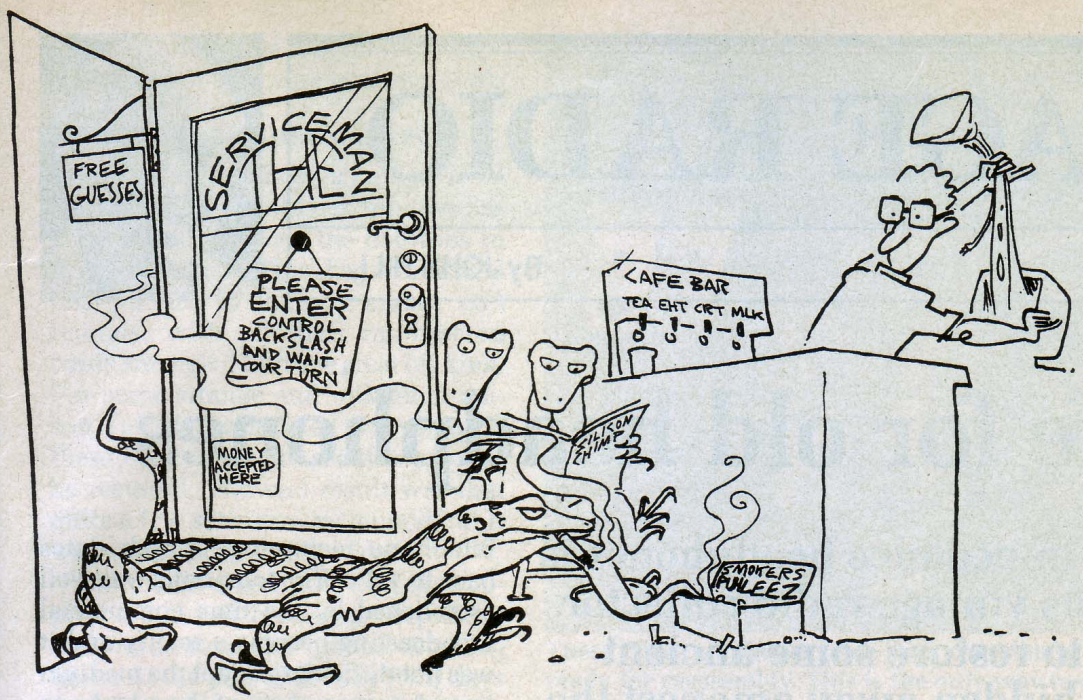



**Fig.1: the NEC N4845 circuit (Daewoo C-900 chassis) is similar in many respects to the N4840, particularly around the line output stage. Note the capacitor connected to pin 4 of the flyback transformer.**




~ANOTHER MONITOR CAME IN
... AND IT WAS SMOKING

is controlled by IC I002-6 (MC-14551BCP). As well, there are two other transistors, an SCR and a second IC (I001, HA17555). I checked Q003 and it was OK

Because the set had worked initially, it appeared that the fault might be heat sensitive and so I decided to try the freezer approach. And I was rewarded with instant success – when I sprayed C001, a 470µF 16V electrolytic, the picture returned to normal.

Replacing the capacitor made the cure permanent and a soak test revealed no further problems. So two down and one to go.

## The WEN monitor

Fortunately, I had dealt with WEN monitors before and already knew about their energy saving functions. In greater detail, this model will shut down when not connected to the computer and will also shut down under software control. However, this one was almost totally dead when connected to a computer, the only sign of life being a high pitched whistle.

Fairly obviously, that high pitched whistle was coming from the switchmode power supply which was closing down because of a short circuit. On the bench, I managed to locate the line output transistor (Q404, 2SC4924) and found that it was shorted. But it wasn't going to be that easy.

First, access to this transistor is very poor. There are two side PC boards and getting at the transistor mounting screws from the lefthand side involves removing the chopper FET (Q801) and its heatsink, as well as C304 (a 2200µF 35V electrolytic). After that, the transistor can only be reached by moving the CRT board which is glued securely to the CRT itself.

In fact, the CRT board required considerable force to prise the socket off the neck of the tube. Fortunately, I managed to do this without breaking anything but I cannot say I was impressed. Nor was I impressed with the general quality of the soldering on any of the boards.

The next challenge was to come up with a suitable line output transistor. My catalogs only went up to 2SC4700 and, as with the two Moebius monitors, I had no circuit and no data. The nearest I could get lay my hands on was a BU508DFI which was worth a try. I fitted one and reworked all the dry joints I could see. When I switched it on, there was power and EHT but still no picture.

I had postponed tackling the CRT socket board because it was enclosed in a metal screen. When I removed it, I saw that its solder joints were even more horrendous than in the rest of set. Anyway, resoldering the CRT socket connections restored the picture, so I replaced the covers and put it aside to soak test.

An hour later, I had another look at it only to find that it was dead and that the power supply was oscillating again. Obviously, my choice of a substitute line output transistor hadn't been a good one. There was nothing for it but to order the correct transistor. It arrived within a week, was duly fitted and fixed the problem.

It had really all been a piece of cake so far. Now for the really difficult part – the "quotes".

The three monitors had taken nearly all day in labour time and estimates of $82.50, $90.00 and $155.00 were given for each job in turn. The first two were accepted readily but the owner of the third monitor baulked at the cost. Later, on discovering the cost of new one, she changed her mind and decided to proceed with the repair.

## Another monitor

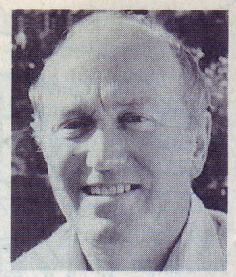
Later that same afternoon, another monitor came in. This time, it was a Videocon 14-inch mono VGA unit (model T-14MS31) and, according to its owner, it was smoking.

When I opened it up, I found that two electrolytic capacitors had exploded, leaving small bits of paper everywhere. Fortunately, I found the metal/plastic covers and was able to identify their values. One was a 2.2µF 100V bipolar capacitor (C523), used as a yoke coupler, while the other was a 1µF 160V electrolytic (C522). The former is hard to get, so I fitted a 2.2µF 450V electro and a 1µF 250V electro and switched on.

The picture was good, so I cleaned up the gunk that was all over everything, reworked a few suspect joints, fitted the cover and left it to soak test. The next day, after it had been soak testing for a few hours, there was a loud bang, followed by a hiss. It had blown up again, destroying the same two capacitors.

This time, I chose a high-current 2.2µF 400V polypropylene capacitor for the yoke coupler and replaced C522 with the same type as before. I left it to soak test for two days before calling the customer and telling him that it was ready. He was grateful for the speedy repair but I did wonder if the service cost was worth it for an old monochrome monitor. **SC**

# VINTAGE RADIO



By JOHN HILL

# A new life for old headphones

**A good pair of high impedance headphones is a must for the serious vintage radio collector. Recently, I decided to restore some ancient units that had been hidden away amongst the cobwebs in my junk shed.**

A small part of my vintage radio activities involves making crystal sets and one and 2-valve regenerative receivers.

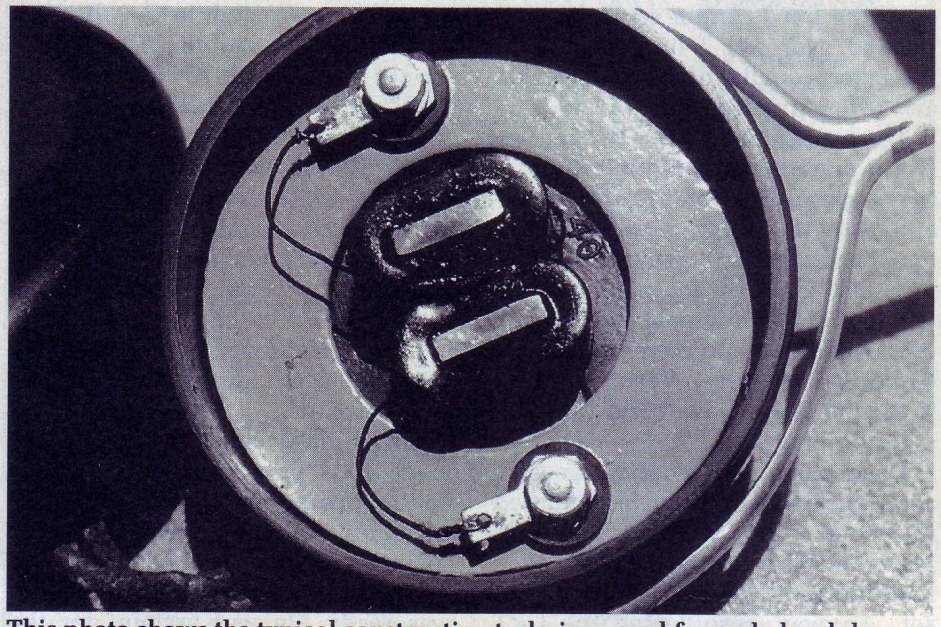
It would appear that I'm not alone in this regard and whenever I feature one of these simple sets in Vintage Radio, they are always well received (excuse the pun) by collector friends and readers alike.

There is one restricting aspect of these simple receivers and that is they require the use of high impedance headphones. Fifty years ago that wasn't a problem. Today virtually no-one makes them and a good pair of old headphones is often quite difficult to find.

Early radio and high impedance headphones went hand in hand and numerous receivers, both valve and crystal types, used headphones. This was because so many of these radios lacked the output power to drive a loudspeaker.

Radio headphones were a steal from telephone technology which dates back to 1876. The telephone was well established by the time commercial broadcasting became a reality and it was not difficult to adapt the medium impedance earpiece of the telephone to high impedance radio use. The telephone microphone also found use in the new science of radio.

It is interesting to note that early radio literature often used the word "telephones" where one would have expected to see "headphones". Some old receivers from the 1920s era even have "TEL" inscribed on the headphone terminals.



**This photo shows the typical construction technique used for early headphones. The two pole pieces were mounted on a permanent magnet and activated a soft iron diaphragm. While not hifi, they were very sensitive and evolved from telephone practice.**

## Modern substitutes

A pair of modern 8-ohm stereo headphones combined with a small output transformer (eg, Dick Smith Cat. M-1100) can make a practical substitute for high impedance phones. This scheme offers several advantages, including better sound reproduction and considerably greater wearing comfort. The disadvantages are a slight drop in volume and the non-originality of modern equipment.

(Editorial comment: a variation of this concept surfaced in the late 1930s when there was a resurgence of interest in regenerative receivers. However, by that time, many of the available high-impedance earphones were no longer working, the fine wire windings having succumbed to the ravages of time.

The trick was to strip off the old winding and rewind the bobbins with much heavier gauge wire (such as 20 or 22 SWG), then feed them via a typical loudspeaker transformer; eg, 5000:8 ohms or even 5000:2.3 ohms.

Some trial and error was needed but, by all accounts, the idea could be made to work very well. And an un-

planned advantage was that the original aspect of the units was retained).

## Raiding the supermarket

For some time now, a supermarket bag stuffed full of old headphones has been stored amongst the cobwebs in my junk shed. This bag contained headphones of various makes and models, with all their moth-eaten cords entangled into one great big knot. For some strange and unknown reason, I suddenly decided to investigate these headphones to see if any could be restored. The end result was that quite a few sets were reclaimed but it was a time-consuming task.

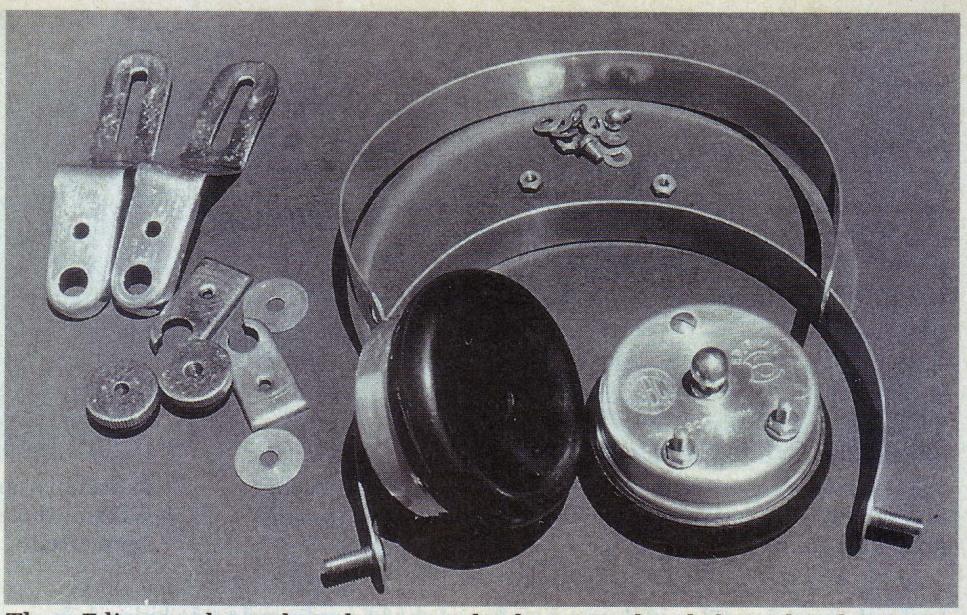
The job involved quite a bit of swapping around of headgear, earphones and cords to make up the working units. At the end of the day (two days actually), I had eight pairs of working headphones and a pile of leftover bits and pieces. These can be used for spare parts, although pole pieces with open windings aren't much good unless rewound.

Some of the brandnames may strike a chord with older readers. Included were Ediswan, Brandes, Siemens, Federal and Brunete models, as well as the more common types made by Brown and STC.

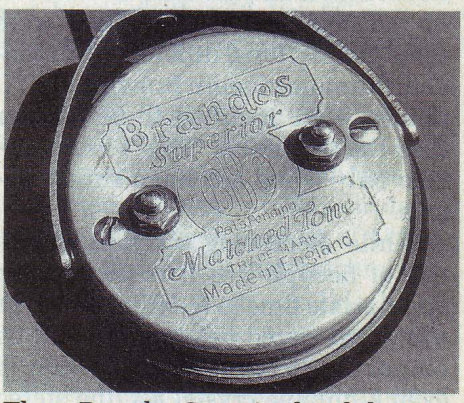
## Performance

The restoration of these old headphones was interesting in that it disproved a few well accepted theories. The general impression amongst collectors is that early headphones from the 1920s era aren't very satisfactory listening devices. This is due to their supposedly poor frequency response and a possible loss of magnetism in their ageing permanent magnets.

To test this theory, I decided to do a comparison a couple of known good sets of phones. In this instance, the two sets of "control" phones were made by Brown and STC. Both were of postwar manufacture and were as new when acquired a few years ago.



**These Ediswan phones have been completely stripped and cleaned and are ready for reassembly. This is the only way to clean things properly.**



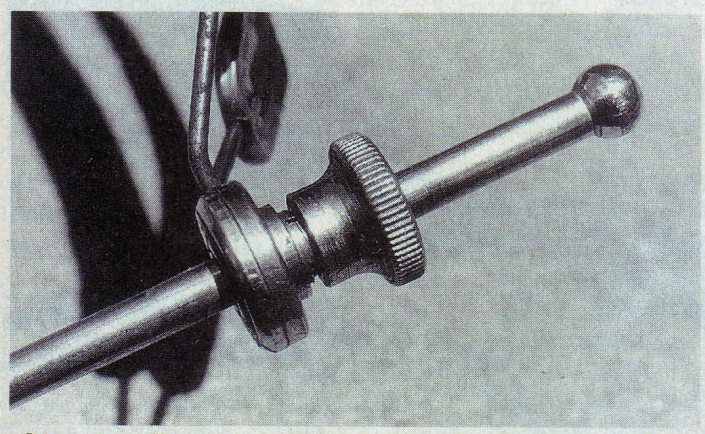

**These Brandes Superior headphones boasted the BBC official stamp of approval, as did many other items of British radio equipment from the 1920s era.**

One would presume that the magnets used in these "late model" headphones would be better and stronger than those made in the 1920s and if there was a difference in performance then it would be easily noticed.

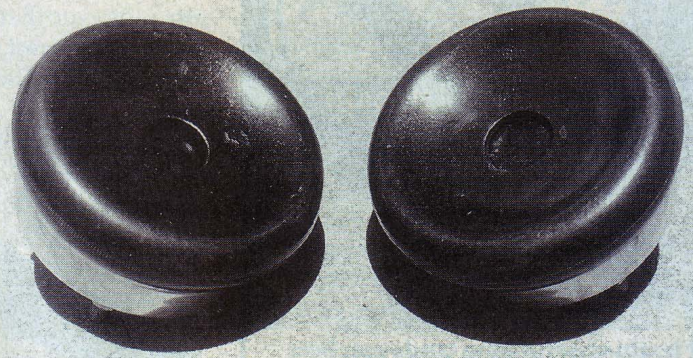
The comparison tests were conducted using a crystal set that was tuned to a distant station. In these circumstances, the signal strength was relatively weak and while speech and music could be clearly heard, it was by no means loud – even when using the good Brown and STC phones.

Trying out the oldies was a pleasant surprise. Most worked very well and their performance was quite comparable to the supposedly good phones. Only the Federal headphones performed poorly and they operated at (subjectively) about half the volume of the others.

Having said that, the frequency response is fairly restricted with this

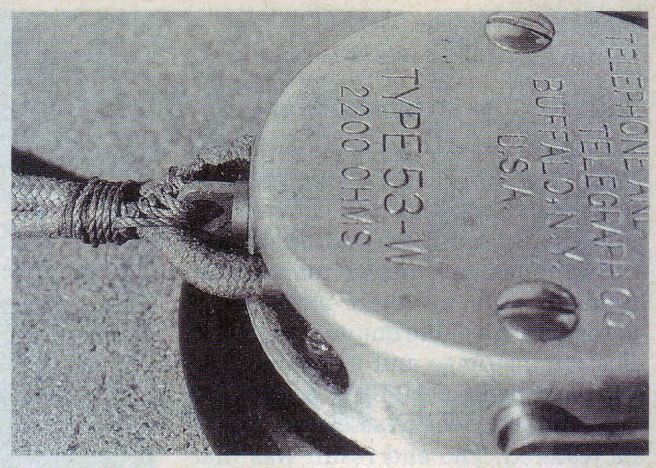


**This neat collet type lock on the Brandes headset can be adjusted to hold the central rod with varying degrees of tension.**



**Made in Paris, these Brunete earpieces are in excellent working order but require suitable headgear to complete the outfit.**

**This cord arrangement is very good in that it is connected and anchored internally. It should give trouble-free service for a long time.**




**Externally anchored cords are not as neat but anything is better than flexible wires that will eventually become open circuit.**

type of earpiece. They all use a soft iron diaphragm and whether they were made in France, England or the USA, the diaphragm thickness is virtually the same on all makes.

It's a fact that this type of headphone was only intended to reproduce speech frequencies and it is unreasonable to expect a wide frequency response from them. Whether by accident or by design, they peaked quite sharply in the middle of the speech range. There is no way that metal diaphragm headphones of this nature could be referred to as being hifi.

When comparing a number of different makes and models, as was done in the comparison test, there were some distinct tonal differences. In general, the more modern Brown and STC phones were inclined to be harsher than the old timers. This was noticeable only when receiving strong signals.

While discussing the tonal qualities of headphones it is perhaps an appropriate time to mention again the use of 8Ω stereo headphones and an output transformer. When listening to even a humble crystal set, the stereo phones give an excellent sound reproduction which includes quite good bass. They don't overload to the same extent on strong local stations either. The same is true when using this equipment on a 1 or 2-valve receiver.

If you have never listened to such a setup it's worth a try if you do have a good set of high impedance phones. The comfort of padded earpieces is a big improvement on hard bakelite.

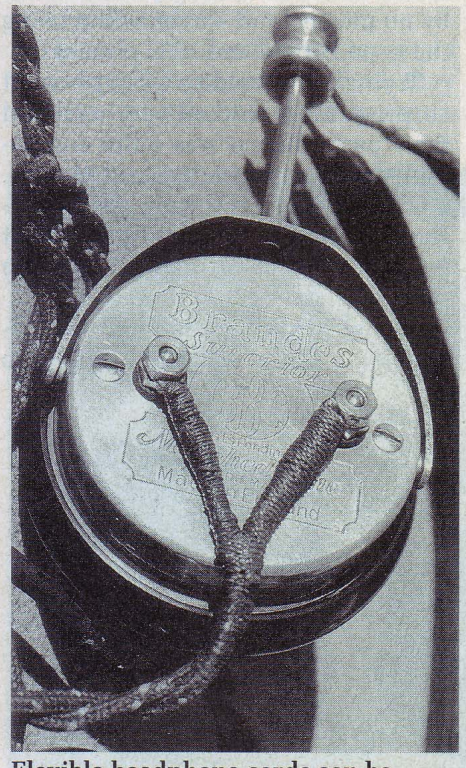
## Restoration problems

There are a number of problems when restoring old headphones. First, it is not uncommon to find the pole-piece windings open circuit and this involves a major repair job unless one is highly skilled in delicate rewinds with hair-thick wire.

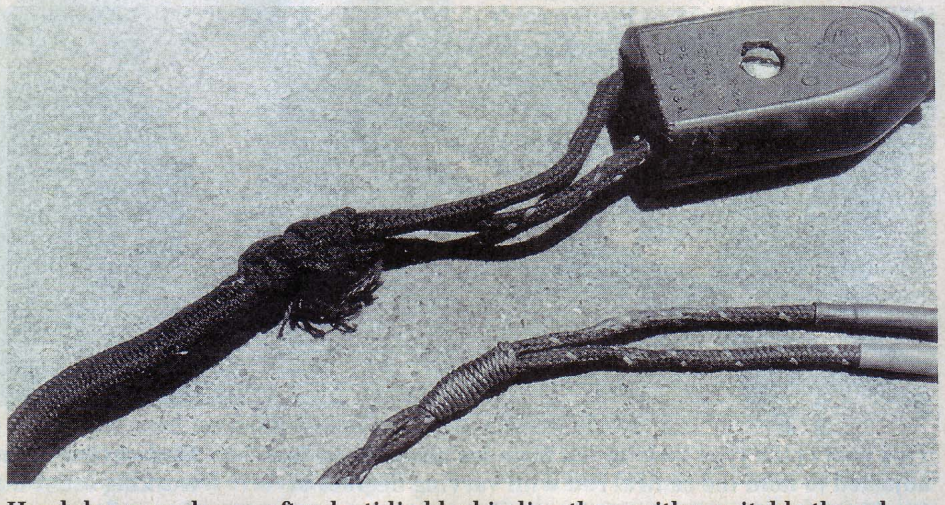
Second, the cords are nearly always in tatters and as most headphone leads are very light and flexible, you cannot expect any old replacement wire to look the part. White figure-8 plastic-covered power cord doesn't have the right appearance somehow!

Third, although not generally my experience, there is little doubt that weak magnets could be a problem with some old headphones. The previously mentioned Federal phones may be suffering from this complaint.

While working on a number of different makes and models it soon became apparent that the way in which



**Flexible headphone cords can be reinforced by binding the leads and applying a suitable glue to stiffen them. External connections invite trouble, however.**



**Headphone cords can often be tidied by binding them with a suitable thread.**

the phone cord is attached to the earpiece is an important factor in the life span of the cord. Some cords are attached to the earpiece by external connections and while this is OK electrically, the constant movement of the cord can soon fatigue the wire where it flexes close to the connection. If the earpiece is free to rotate, this also aggravates the situation.

In better designs, there is some provision to anchor the cord and restrict the movement of the earpiece in order to prevent the cord from flexing and pulling at this vulnerable point. This is a good aspect to look for when purchasing a set of old headphones.

The most secure method is where both the connections and cord anchor are internal, with the cord exiting the earpiece through a grommetted hole. This system is perhaps the best way to tackle the problem as both the connections and the cord securing device are well protected. Headphones with waggling external connections will eventually give trouble.

At the other end of the cord, there were two methods used to connect the phones to the receiver: (1) via a standard 1/4-inch headphone plug; or (2) via individual metal tips that were held by terminals or binding posts. Fitting lead tips to old headphone cords is not an easy job, by the way.

When rewiring headphone cords, one must pay strict attention to earpiece connection polarity. Where DC flows through the windings, incorrectly wired headphones can cause demagnetisation of the permanent magnets. Leads marked red or with a red trace indicate the positive side of the connections.

The impedance of old headphones varies considerably. Amongst those mentioned in this story, the high-impedance types ranged from 1kΩ to 2.2kΩ per earpiece, with most being the more common 2kΩ variety. The crystal set comparison test using a distant station showed no discernible difference in performance between these values. It made no difference whether the impedance was 1kΩ or 2kΩ – the performance was identical!

Even a 120Ω set of STC phones performed fairly well on the crystal set, so high-impedance is not always a critical factor by any means. The 8Ω stereo headphones do work but nowhere near as well as when coupled via an output transformer.

**A modern pair of 8-ohm stereo headphones and a matching transformer can be substituted for high-impedance headphones. The M1100 transformer is a particularly handy unit as it has 2, 4, 8 and 16Ω secondary tappings. The latter matches perfectly with two 8Ω earpieces connected in series. The 5kΩ primary is compatible with crystal sets and one and 2-valve regenerative receivers.**

Incidentally, some impedance ratings can be rather confusing. Because the earpieces on old headphones are connected in series, two 2kΩ earpieces give an impedance reading of 4kΩ at the lead tips. Some manufactures referred to such units as 2kΩ headphones while others called them 4kΩ headphones.

When using two sets of headphones on a crystal set it will be noted that the volume decreases if the phones are connected in parallel. If they are connected in series however, two pairs of phones will produce about the same volume as one. One of my boyhood crystal sets had three terminals for the headphones with the centre terminal connected to nothing. Its purpose was to join two pair of phones in series so that my brother could listen in as well.

Many radio collectors are always scrounging around, looking for other things to collect apart from radio receivers. In fact, any item associated with radio is generally considered collectable.

If it is good enough to collect and display a range of vintage loudspeakers, then a selection of vintage headphones should be equally valid. If they are in working order and still retain their original cords, then so much the better. Old headphones are also necessary when displaying items such as genuine early crystal sets and small regenerative receivers.

So if you have a few pairs of old headphones in your collection, you may find repairing them an interesting challenge. It certainly makes an interesting change from the more conventional restoration jobs. **SC**

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**December 1995:** Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Dolby Pro Logic Surround Sound Decoder Mk.2, Pt.2; Knock Sensing In Cars; Index To Volume 8.

**January 1996:** Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

**February 1996:** Three Remote Controls To Build; Woofer Stopper Mk.2; 10-Minute Kill Switch For Smoke Detectors; Basic Logic Trainer; Surround Sound Mixer & Decoder, Pt.2; Use your PC As A Reaction Timer.

**March 1996:** Programmable Electronic Ignition System; Zener Tester For DMMs; Automatic Level Control For PA Systems; 20ms Delay For Surround Sound Decoders; Multi-Channel Radio Control Transmitter; Pt.2; Cathode Ray Oscilloscopes, Pt.1.

**April 1996:** Cheap Battery Refills For Mobile Telephones; 125W Power Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3; Cathode Ray Oscilloscopes, Pt.2.

**May 1996:** Upgrading The CPU In Your PC; High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Duplex Intercom Using Fibre Optic Cable; Cathode Ray Oscilloscopes, Pt.3.

**June 1996:** BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

**July 1996:** Installing a Dual Boot Windows System On Your PC; Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-bit Data Logger.

**August 1996:** Electronics on the Internet; Customising the Windows Desktop; Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

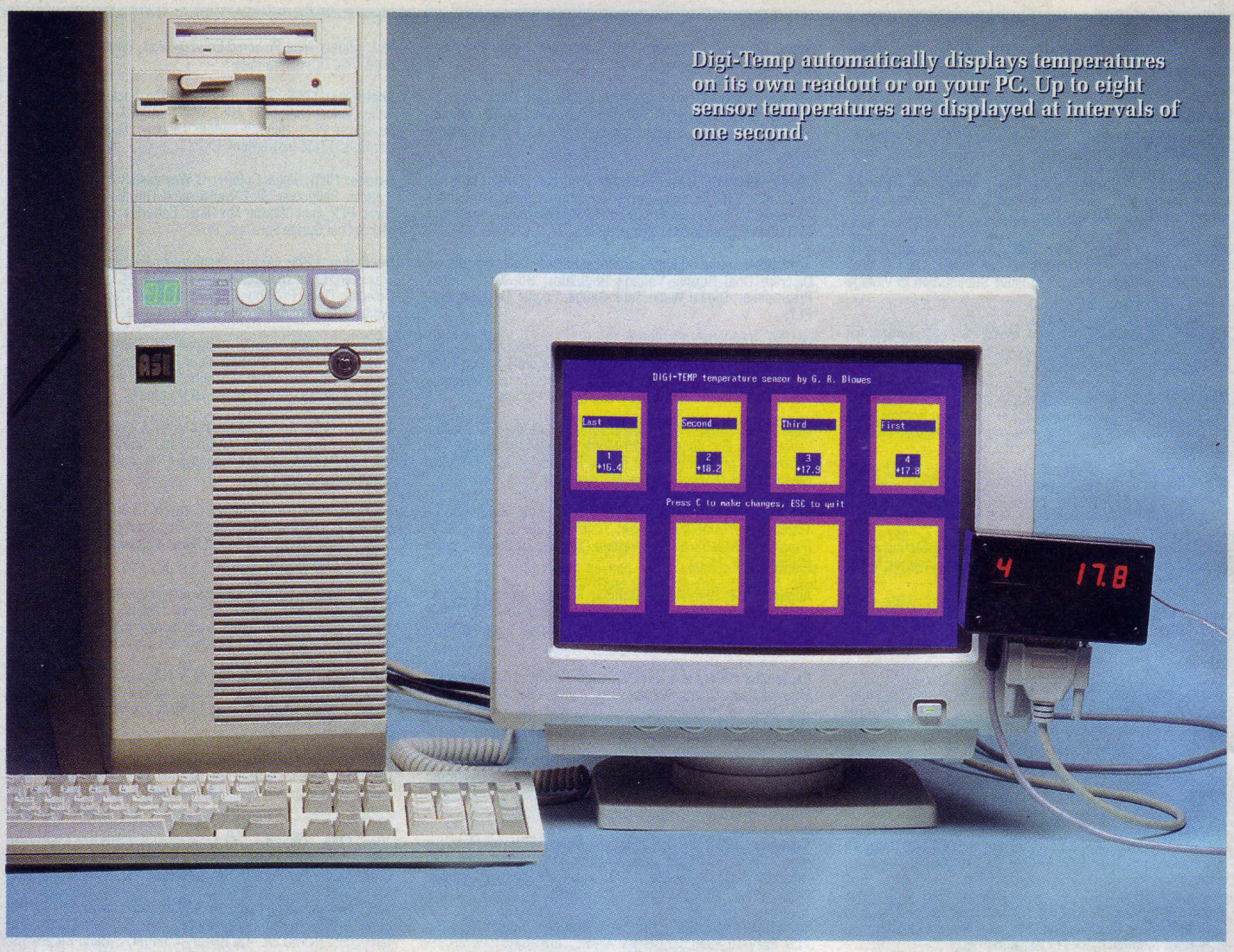
**September 1996:** Making Prototype Parts By Laser; VGA Oscilloscope, Pt.3; Infrared Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Feedback On Programmable Ignition (see March 1996); Cathode Ray Oscilloscopes, Pt.5.

**October 1996:** Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; Infrared Stereo Headphone Link, Pt.2; Build A Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

**November 1996:** Adding An Extra Parallel Port To Your Computer; 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; How To Repair Domestic Light Dimmers; Build A Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

**December 1996:** CD Recorders – The Next Add-On For Your PC; Active Filter Cleans Up CW Reception; Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Volume 9.

**PLEASE NOTE:** November 1987 to August 1988, October 1988 to March 1989, June 1989, August 1989, May 1990, February 1992, September 1992, November 1992 and December 1992 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or tear sheets) at $7.00 per article (includes p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date is available on floppy disc at $10 including packing & postage.




Digi-Temp automatically displays temperatures on its own readout or on your PC. Up to eight sensor temperatures are displayed at intervals of one second.

# Digi-Temp monitors eight temperatures

**This little device will monitor & display the temperature at eight different locations at 1-second intervals. And you can use it to log those temperatures into your computer for air conditioning or process control. The temperature range is from -50°C to 99.9°C.**

By GRAHAM BLOWES

Digi-Temp is a self-contained temperature monitor which can be used by itself or in conjunction with your computer for control applications. In concept, it is similar to those el-cheapo indoor/outdoor temperature sensors which are frequently advertised. Those units are thermistor based and their accuracy seems quite variable, which is to be expected; after all they are cheap.

The accuracy of some units, would you believe, is also affected by temperature! Digi-Temp has none of those problems, being a purely digital de-

vice. It can transmit the data from each sensor to the Rain Brain sprinkler controller (published in the January 1996 issue of SILICON CHIP) and to your PC.

If data transmission is not needed, no problem! Just power it with a 12VDC plugpack and you have a standalone unit that can be used anywhere, as it has its own LED display. It could be installed in your car or on a bookshelf at home.

Digi-Temp is a no-frills project. It is just a plastic box with a 4-digit readout. There is just one PC board which fits snugly inside the box. There are no switches to operate. You just plug it in and it automatically cycles through the temperatures at eight different locations. There is also a 25-pin D socket for connection to the serial port of your computer.

The data transmission is an all ASCII string which can be received on a normal communications program, such as Telix or the Windows terminal program. I have written a simple Qbasic program that could form the basis of a simple data logger on your PC.

As can be seen from the block diagram in Fig.1, the DS1820 temperature sensors simply connect onto a single wire bus (plus supply lines) wherever a device is needed.

Temperatures from -50°C to +99.9°C can be displayed on this unit. The accuracy of each device is ±0.5°C with a display resolution of 0.1°C. Best news of all is that the unit does not require calibration of any sort; just build it and go!

Digi-Temp uses a Z86E08 microcontroller to communicate with the DS1820 temperature sensors and with external devices such as your PC and the Rain Brain sprinkler controller referred to earlier. The data transmitted from the DS1820 has a checksum attached to it, so any errors in transmission are detected. The same method of checksum verification is used when the data is re-transmitted to your PC.

The Rain Brain will ignore any data where the CRC (cyclic redundancy check) is wrong, as will the Qbasic program mentioned earlier. Further, if the Z86E08 detects a CRC error in any of the DS1820s, it flashes the number of the offending sensor for a few seconds, then resets itself and interrogates the single wire bus to re-establish contact with all the DS1820s connected.

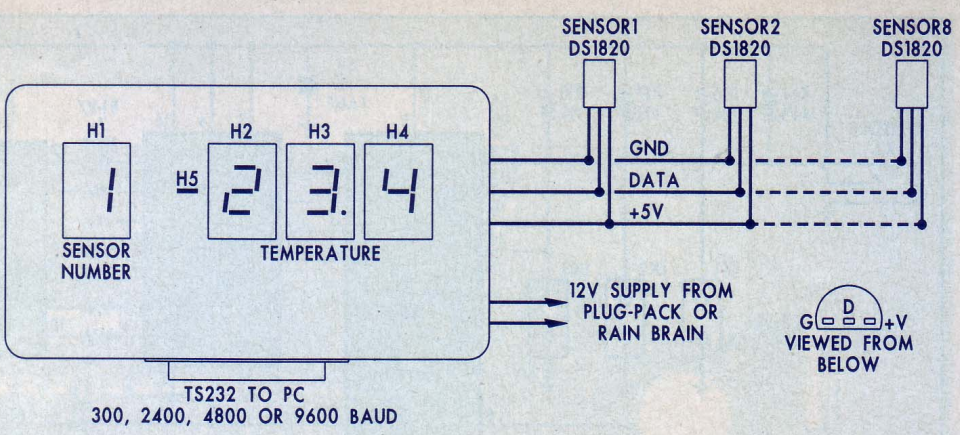



**Fig.1: block diagram for the Digi-Temp. Up to eight DS1820 temperature sensors can be daisy-chained together.**

| SCRATCHPAD RAM | BYTE |
|---|---|
| TEMPERATURE LSB | 0 |
| TEMPERATURE MSB | 1 |
| TRIP POINT BYTE 1 | 2 |
| TRIP POINT BYTE 2 | 3 |
| RESERVED | 4 |
| RESERVED | 5 |
| COUNT REMAIN | 6 |
| COUNT PER °C | 7 |
| CRC OF ABOVE DATA | 8 |

| EEPROM |
|---|
| TRIP POINT BYTE 1 |
| TRIP POINT BYTE 2 |

**Fig.2: this is memory map for the DS1820 digital temperature sensor.**

## DS1820 temperature sensors

Made by Dallas Semiconductor Corporation, the DS1820s are clever little beasties. Each device has its own unique 64-bit ROM number. The first eight bits form the family code, the next 48 bits is a unique ID number, and the last eight bits is the CRC checksum of the previous 56 bits. The DS1820 has nine bytes of scratchpad RAM plus two bytes of EEPROM. The EEPROM bytes are linked to programmable alarm trip points (upper and lower).

The device has a repertoire of 11 commands, five of which are ROM functions while the other six are MEMORY functions. The most complex command is called ROM SEARCH. This process enables all the connected devices to be identified by a process of elimination.

This process is quite tricky, so I recommend you get a copy of the data sheet to get the full picture. It is possible to identify 75 different one-wire devices per second. Dallas Semiconductor has a web site at http://www.dalsemi.com/.

The DS1820 counts the number of clock cycles that an oscillator with a low temperature coefficient goes through during a period determined by a high temperature coefficient oscillator. The low temperature coefficient means that it is unaffected by temperature, whereas the high temperature coefficient oscillator varies according to the temperature around it.

Once a temperature conversion is completed, the device places the resulting 16-bit, sign-extended two's complement binary number (-55 to +125) into the scratchpad RAM, ready for the master to read it (when a 'READ SCRATCH' command is issued). This number has a resolution of 0.5°C. Greater resolution can be obtained by performing the calculation shown in equation 1 below.

This calculation uses the values left in the counters, once a conversion has been completed. Fig.2 shows the memory map of the DS1820.

## Circuit details

Fig.3 shows the circuit diagram of the Digi-Temp. IC1 is a Z86E08 microprocessor clocked by an 8MHz crystal

### Equation 1

Temperature = temperature read - 0.25 + [(count per °C - count remain)/count per °C]
where temperature read = (16-bit number from temperature MSB and LSB)/2

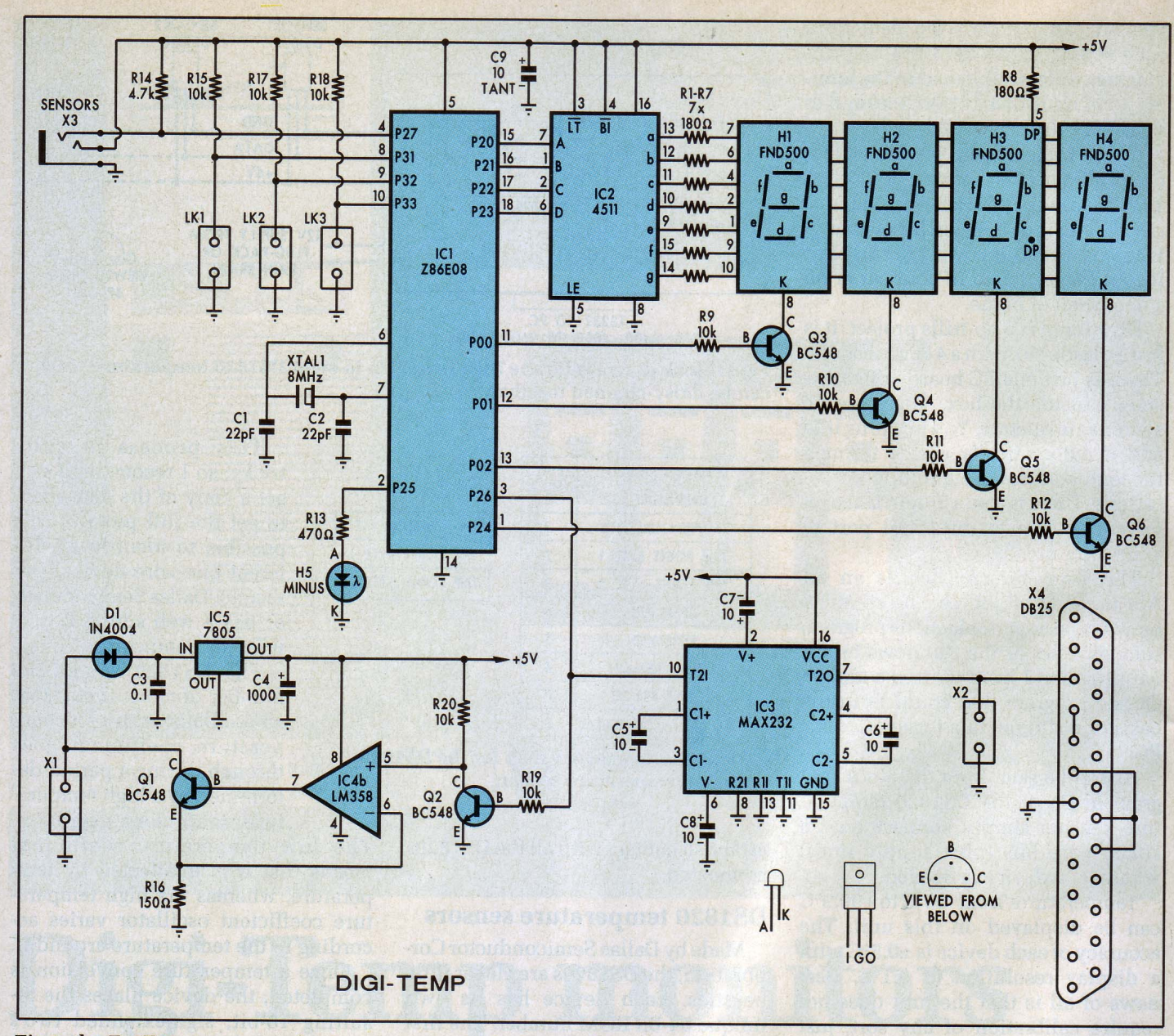



**Fig.3: the Z86E08 programmed microprocessor is the heart of the circuit. It interrogates each of the temperature sensors and displays their values on the 4-digit readout. It can also send the information to a PC via an RS232 port.**

which is internally divided by two for all internal timing. Both internal timers of the Z8 are used; one to multiplex the 7-segment LED displays via Q3-Q6 at a 1kHz scan rate and the other for general timing duties.

IC2 converts the BCD output of port 2 (bits 0 to 4) to the 7-segment code for the LEDs.

Op amp IC4b and Q1 form a voltage-to-current converter. The input voltage applied to pin 3 of IC4a will cause an equivalent voltage to be dropped across the 150Ω emitter resistor for Q1. Using this circuit means a fixed amount of current is always drawn from the supply, no matter (theoretically) what the resistance of the wires between the Rain Brain and the Digi-Temp. This method also allows minimal disturbance to the 5V supply provided by the regulator, IC5.

Links LK2 and LK3 provide baud rate selection, although in practice 9600 baud seems to work very well, even over distances of 100 metres. Link LK1 was intended to be used when the Digi-Temp was operated without the LED displays when connected to the Rain Brain controller. This mode, however, is not used so it can be left out (pin 8 high).

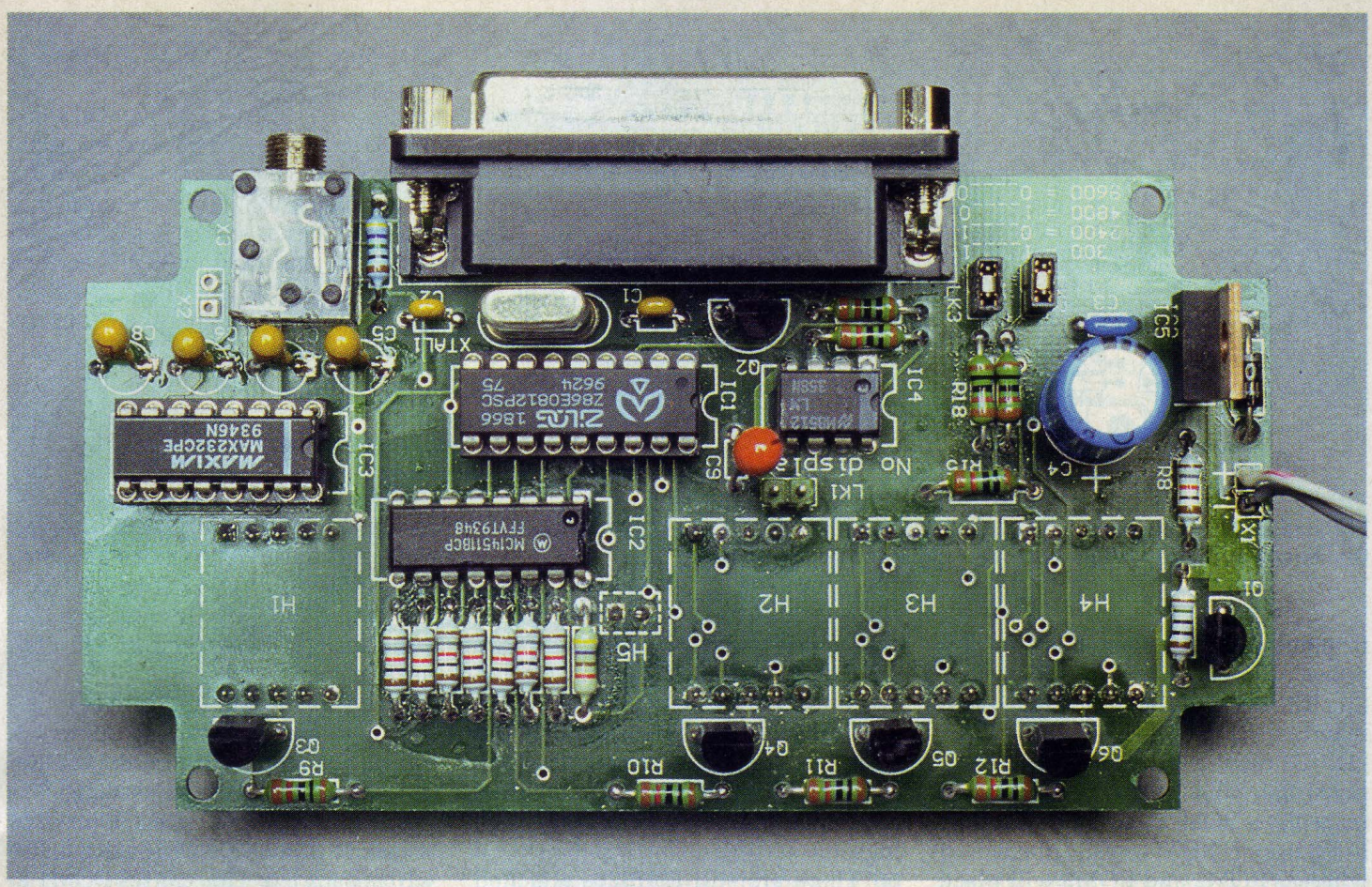
If the Digi-Temp is only to be used to transmit data to a PC, then the LED displays and associated hardware can be left off the PC board.

R14 is the 4.7kΩ pull-up resistor associated with the DS1820 sensors. The sensors are open Drain, meaning that if the internal FET of any of the connected sensors is switched on, then a logic 0 is presented to P27.

## Software

Because there is only one wire for both transmit and receive operations, timing is critical. The timing is divided into two main groups, 'read' slots and 'write' slots. Refer to Fig.4 for details of these slots.

When IC1 comes out of RESET, port pin P27 is configured as an output. It sends a RESET pulse out to all the DS1820s connected to the single wire bus. The RESET signal is a logic 0 between 480µs and 960µs long. After this, P27 is set as an input. All con-



**Above: all the components except for the LED displays are mounted on this side of the PC board. Note that the final version differs slightly from the unit shown here.**

nected DS1820s respond simultaneously with a presence signal. The presence pulse is a logic 0 between 60µs and 240µs long.

IC1 then issues a 'ROM SEARCH' command. This process is the repetition of a three step routine: read a bit, read the complement of the just read bit, then write a bit back to the sensor(s). IC1 performs this routine on every bit of the DS1820 ROM. After one complete pass (64 cycles), IC1 knows the contents of the ROM in one DS1820. The rest of the connected DS1820s are identified through additional passes. The following is a simplified version of an example in the data sheet.

Say we have four devices with the following ROM code segments:

| | |
|---|---|
| ROM1 | 00110101... |
| ROM2 | 10101010... |
| ROM3 | 11110101... |
| ROM4 | 00010001... |

The search process is as follows:

( 1). IC1 issues a RESET to the DS1820(s). All connected DS1820s

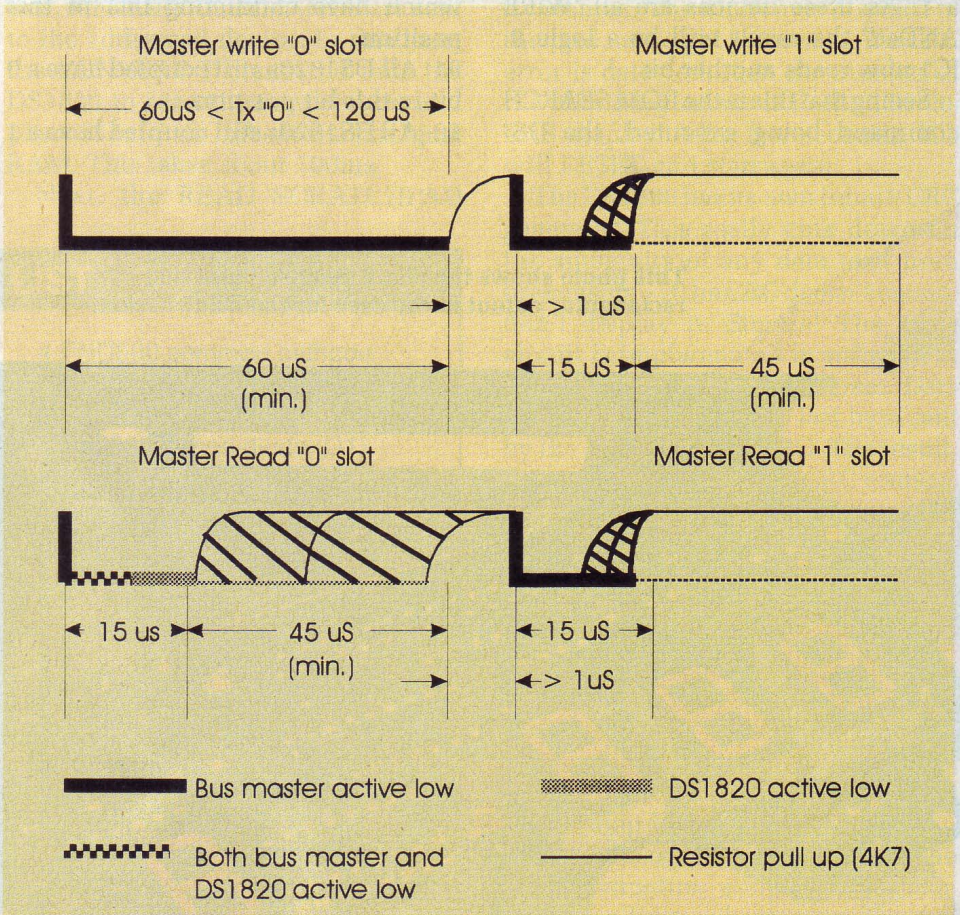



**Fig.4: because there is only one wire for both transmit and receive operations to the DS1820 sensors, timing is critical. The timing is divided into two main groups, 'read' slots and 'write' slots, as shown here.**

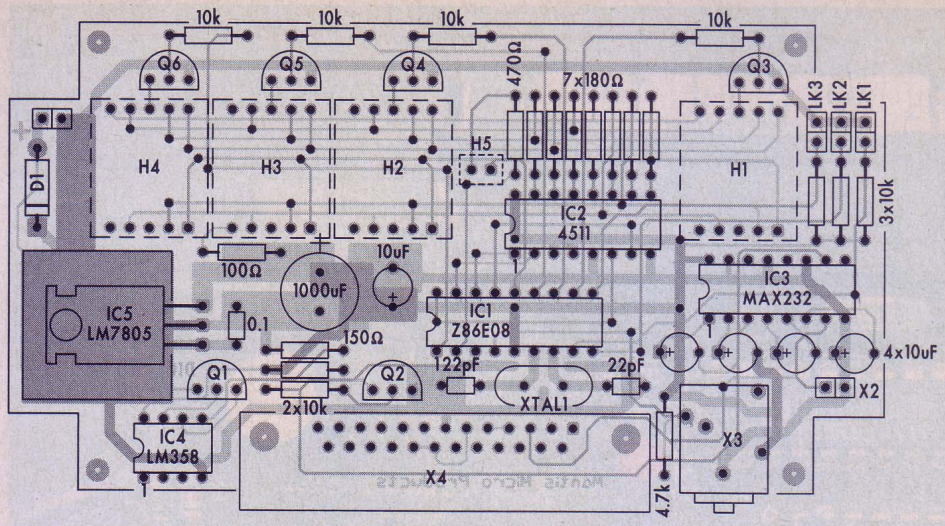



**Fig.5: this is the component overlay for the double-sided PC board. Note that this board is slightly different from that shown in the photos.**

respond with a simultaneous presence pulse.

(2). IC1 issues the ROM SEARCH command.

(3). IC1 reads a bit. Each DS1820 will place the value of the first bit of its respective ROM code onto the bus. ROM1 and ROM4 will place a 0 whereas ROM2 and ROM3 will place a 1. As these devices are all 'WIRE ANDed' the result will be a logic 0. IC1 now reads another bit.

Seeing that this is the ROM SEARCH command being executed, the DS-1820s will now place on the bus the complement of the ROM code bit that was previously sent. ROM1 and ROM4 will place a 1 whereas ROM2 and ROM3 will place a 0. The result, again, will be logic 0. Each subsequent 'dual read' will result in one of the following:

00 There are still DS1820s attached which have conflicting bits in this position.

01 All DS1820s still coupled have a 0 bit in this bit position.

10 All DS1820s still coupled have a 1 bit in this position.

11 There are no DS1820s attached to the bus.

So far, IC1 has determined that some DS1820s have a 0 as the first bit of the ROM code whereas the rest have a 1 in this position. You are probably thinking, how can this be of any use! Well, IC1 will now write a 0 back to the DS1820s. This will cause all the DS1820s with 1 as the first bit of the ROM code to switch off, which in this example are ROMs 2 and 3. IC1 could write back a 1, which would cause ROM1 and ROM4 to switch off.

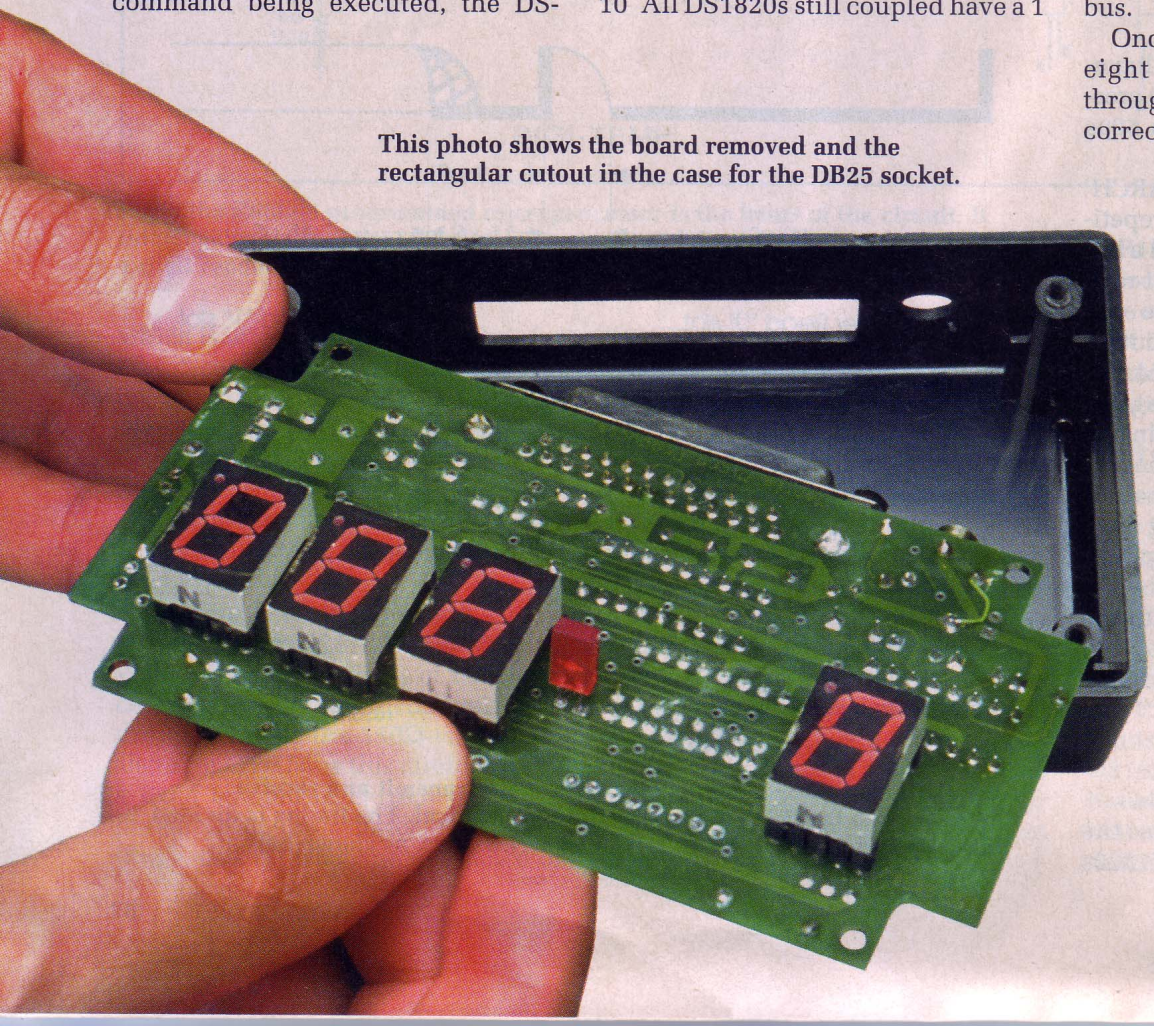
Step 3 is repeated again. This time the 'dual read' will result in 01, which means that all DS1820s still connected to the bus have a 0 bit in this position. You can see that this is the case with ROM1 and ROM4. IC1 writes back a 0, which keeps ROM1 and ROM4 connected.

Step 3 is repeated again. This time the 'dual read' will result in 00, which means that this ROM code position has a conflicting bit; ie, either ROM1 has a 0 and ROM4 has a 1 (or vice versa). In this case, ROM4 has a 0. IC1 writes back a 0. This causes ROM1 to switch off, leaving only ROM4 still connected. Subsequent 'dual reads' will result in either 01 or 10 because ROM4 is the only device left on the bus.

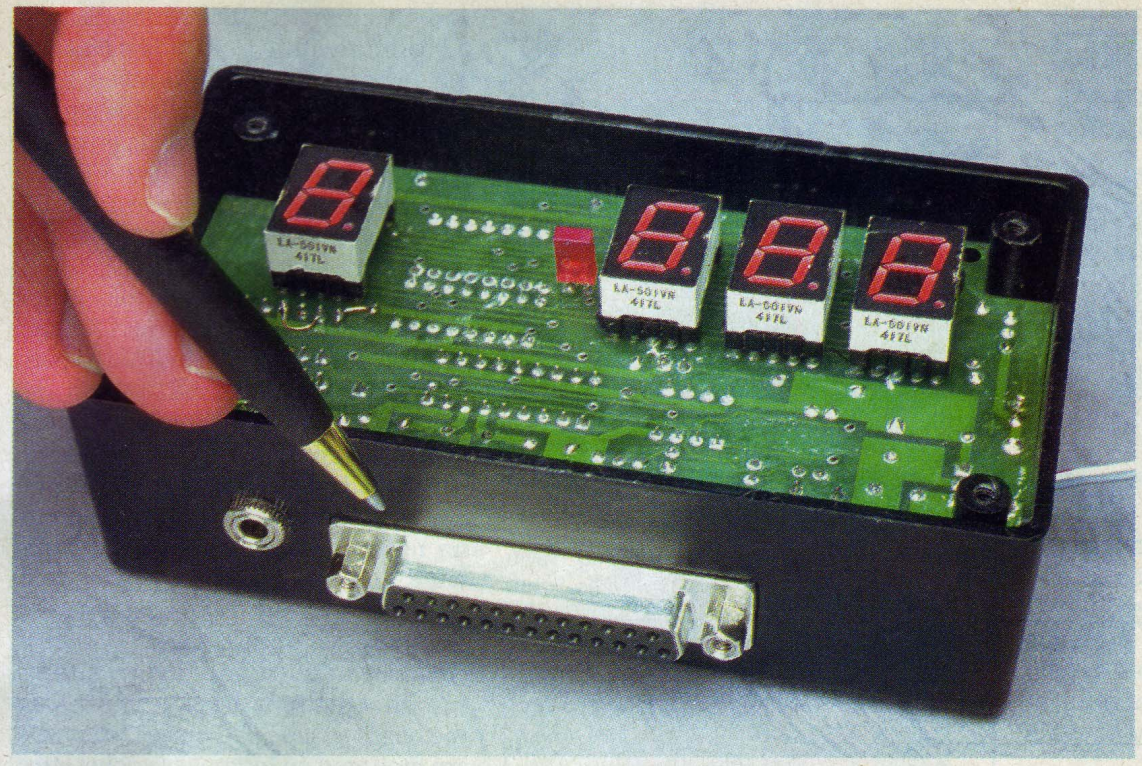
Once 64 bits have been read, the eight received bytes are passed through a CRC calculator, which if correct, will yield a zero. The whole process is repeated for the other DS1820s. To prevent reading the same path over and over again, the 'pathway' has to be marked in much the same way as if you were exploring a maze.

Each time you come to a fork (dual read = 00, meaning 0 or 1 in a bit position), mark it, so that next time you encounter this fork, take the other path (ie, write back a 1). This path is also marked, so that next time you encounter a fork where both paths are marked, back track to the previous fork, where there is still an unmarked path. As noted earlier, it is tricky!

The ROM codes of all the detected DS1820s are stored in the internal RAM



**This photo shows the board removed and the rectangular cutout in the case for the DB25 socket.**



**The PC board is mounted upside down in the case with the displays facing upwards, as shown in this photograph. The 25-pin D socket connects via a standard RS232 cable to the serial port of your computer.**

of the Z8 controller. A maximum of 64 bytes is set aside for this task, which is enough for eight DS1820s. Once all connected DS1820s have been detected, the number of devices found is displayed on the lefthand digit of the display.

After this, all DS1820s are RESET and the MATCH ROM code is sent to all DS1820s. This causes all the DS1820s to 'sniff' the bus for their own unique ROM code. The ROM code of the first device is read from RAM and sent out on the bus (note: all data is least significant bit first). After this, MEMORY COMMANDS are sent to the addressed device. In this case, the CONVERT T command tells the DS1820 to read the temperature and place it into its onboard scratchpad RAM. This takes about 500ms.

Next, the READ SCRATCHPAD command is sent to the DS1820. This causes the DS1820 to send the contents to IC1. Note that all nine bytes are sent, even if they are not necessarily wanted. The ninth byte is a CRC of the previous eight bytes sent. If a CRC error is detected, then the number of the offending sensor is flashed in the LHS display. After five seconds, IC1 will RESET and start again.

The DS1820 has its own inbuilt CRC generator. This really cuts down on the ambiguity of any data read from the sensors – if the CRC doesn't match, don't display it. Simple! The same circuit is implemented in software in the Z8 and the Qbasic program. Data is fed in, LSB first. The last byte sent by the DS1820 is the CRC. The result, once passed through the CRC routine, will be zero if all bits are received correctly.

This unit is designed to work unattended, therefore the Z8 watchdog instruction (WDT) is used. Any spikes that upset the Z86E08 will cause it to RESET. The WDT instruction, once enabled, has to be 'refreshed' every 10ms or so. It is set up in such a way, that the micro will RESET if it is caught in any loop longer than required.

Many programmers misuse the WDT instruction, simply putting it in the timer loop, where it will be 're-freshed', regardless of whether the main loop has crashed or not. A method I have found that seems to

## PARTS LIST

1 plastic box, 120 x 65 x 39mm
1 PC board, 113 x 63mm
1 DB25 socket with rightangle mounting
1 3.5mm stereo socket
1 3.5mm stereo jack plug
1 8MHz crystal

**Semiconductors**
1 Z86E08 programmed microprocessor (IC1)
1 4511 BCD to 7-segment decoder (IC2)
1 MAX232 RS232 transmitter (IC3)
1 LM358 dual op amp (IC4)
1 7805 5V 3-terminal regulator (IC5)
1 to 8 DS1820 digital thermometers
6 BC548 NPN transistors (Q1-Q6)
4 FND500 common cathode 7-segment displays (H1 - H4)
1 red rectangular LED (H5)
1 1N4004 silicon diode (D1)

**Capacitors**
1 1000µF 16VW electrolytic
1 10µF 25VW tantalum electrolytic
4 10µF 16VW electrolytic
1 0.1µF monolithic
2 22pF ceramic

**Resistors**
9 10kΩ
1 4.7kΩ
1 470Ω
8 180Ω
1 150Ω

**Miscellaneous**
Heatshrink tubing, IC sockets, solder.

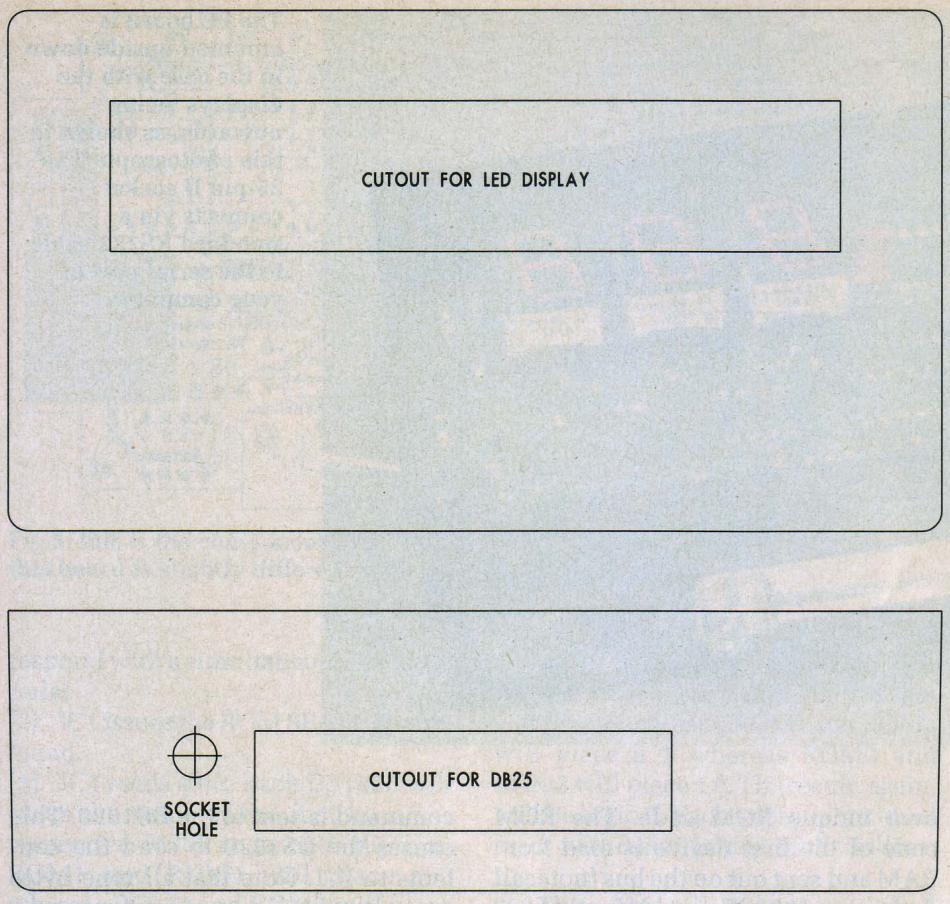



**Fig.6: use this template to cut the rectangular hole for the DB25 socket and for the display window in the lid of the case.**

work OK is to put the WDT instruction in a timer routine, but within a loop that always executes, but only if a variable in the main loop is loaded with $FF at every reasonable opportunity. The variable is decremented towards zero in the timer routine, and at the same time executing the WDT instruction. If the variable fails to be loaded with $FF and hits zero, the WDT instruction is bypassed, thereby resetting the processor.

The Qbasic program written for this project displays eight boxes on the screen. As the data is received from the Digi-Temp, the box associated with the sensor number is updated. Each box can be given a name (eg, inside, outside, etc) which is saved to disc. With a little effort, a good data logger could easily be developed from this program.

A disc containing the full source code (in Z8 assembler) and the Qbasic PC program (Z8temp.BAS and Z8temp.EXE) is available – see details in "Where To Buy The Kit".

## Construction

All the circuitry for the Digi-Temp is mounted on a small PC board measuring 113 x 60mm. This mounts the DB25 socket and the 3.5mm stereo socket so there is no wiring except for the three wires which run away to the sensors. The board has corner cutouts so that it becomes a snug fit inside the plastic case which measures 120 x 65 x 39mm.

Fig.5 shows the component overlay for the PC board. Note that it is a double-sided board and the four LED displays are mounted on one side, while all the rest of the components are mounted on the other. Another point which should be made is that the PC layout in Fig.5 differs from that of the prototype board shown in the photos.

Two rectangular cutouts need to be made in the case, one as a clearance hole for the bracket of the DB25 connector and the other in the lid, for the display window. This is then fitted with a piece of red Perspex. Templates for the two cutouts are shown in Fig.6.

Assembly of the PC board is straightforward although there are a few points to be noted. Resistors R1-R7 and R13 are all bunched together so be careful with R13 as it is 470Ω not 180Ω! The cathodes of the rectangular LED and D1 are denoted by the square pad, as are the positive legs of all electrolytic capacitors. The 3-terminal regulator IC5 is bolted to the PC board and the copper pattern provides a degree of heatsinking.

Rather than use removable links, just solder wire straps in the LK2 and LK3 positions, and leave LK1 open. The DB25 socket, MAX232 and capacitors C5-C8 can be left off if the unit is not going to be used with a PC.

The PC board sits snugly on the ribs halfway down in the case, so there is no need to use any mounting hardware.

Actually, as only two wires are used for the RS232 option, the DB25 socket could be omitted and just two wires run directly from the X2terminals on the board to the PC. The LED displays are mounted on lengths of socket strip to bring them closer to the Perspex window.

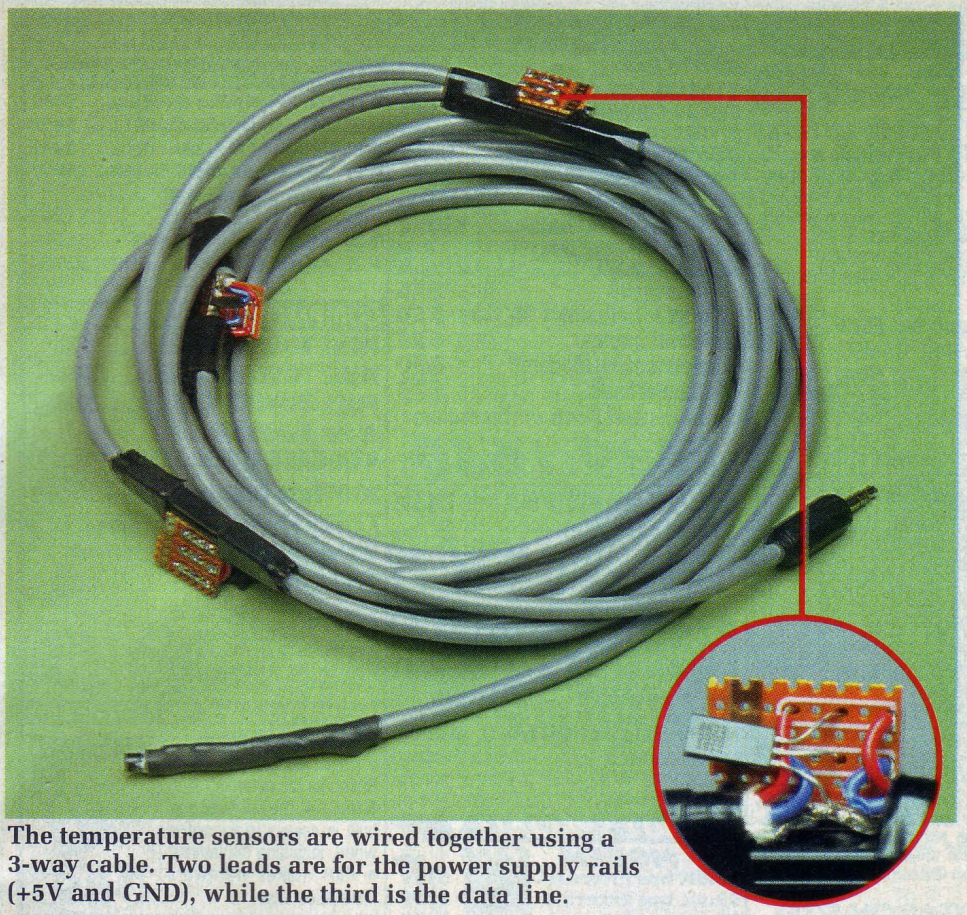
Solder a different coloured wire to each leg of the sensor(s) and cover each connection with a length of suitable heatshrink, then cover the whole with a larger piece.

I have found that encasing the DS1820 completely in heatshrink tends to insulate it too much, so it is better to cover the sensor to about halfway up its body, then shrink it. Once this is done, smear some silicone sealant thinly around the protruding part of the sensor to waterproof it. If the unit is to be used outdoors, don't use the 3.5mm plug and socket; solder the wires direct to the PC board. A hole is drilled for the power\data pair.

## Temperature sensor setup

There is really no setup required when the Digi-Temp is used as a standalone unit. Just connect a 12VDC plugpack and switch on. When it is first switched on, the unit will display the number of sensors found on the lefthand side digit, then the unit will then display the temperature of each one, at one second intervals.

If you want the sensors in a particular order, you will have to temporarily connect them all, then switch on the unit. Carefully remove a sensor while the power is on (they are open Drain, so will come to no harm). The display will flash the number of the one re-



**The temperature sensors are wired together using a 3-way cable. Two leads are for the power supply rails (+5V and GND), while the third is the data line.**

moved. Repeat this process for all the sensors. It is best to mark them with the number so that you know the order in which to permanently connect them.

## PC operation

The data format transmitted by the Digi-Temp is set out below (the commas are not in the data but are included here for clarity):

(CR),n,(sign),x,x,.,x,C,C

where CR = $0D;
n = sensor number 1 to 8 ($31 to $38);
sign = + or - ($2B or $2D);
x = ASCII digits 0 to 9 ($30 to $39);
. = decimal point ($2E); and
C = ASCII HEX No.'s 0 to 9, A to F ($30 to $39, $41 to $46)

CC is the CRC of the previous data (but not the CR). It has to be decoded back to its binary equivalent before it can be passed through the CRC routine in the Qbasic program (and the Rain Brain).

The reason that this is done is so that an ordinary communications program can read the output of the RBST2. If the straight binary CRC was transmitted, it would cause all sorts of hash to appear on the screen. For instance, a binary $AB is transmitted as ASCII 'AB' ($41,$42). **SC**

## Where To Buy The Kit

Parts for the Digi-Temp are available as follows:

| Item | Price | P&P |
|---|---|---|
| Programmed Z86E08 microprocessor | $18 | incl. |
| PC board | $15 | $2 |
| DS1820 temperature sensor | $11 | incl. |
| Z8 source code disc plus Qbasic program | $12 | incl. |
| Full kit (includes one DS1820) | $75 | $3 |
| Full kit (less RS232 parts) | $60 | $3 |

Payment may be made by cheque or money order to Mantis Micro Products, 38 Garnet Street, Niddrie, Vic 3042. Phone/fax 03 9337 1917.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| 8M 72 pin EDO | $59 | $55 |
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One of the real attractions of this digital scope, based on a VGA monitor, is that you don't have to peer at the display- it is large, bright and the different coloured traces and graticule make it easy to interpret what's happening.

## LOW COST RF TEST OSCILLATOR

A low cost RF oscillator design that is suitable for checking and aligning HF radios and other equipment operating between 350kHz and 30MHz. Features digital frequency readout, the ability to provide either CW or modulated output and also audio and 1 MHz reference signals from auxiliary outputs at the rear. **EA May '96**

## HIGH PERFORMANCE PLAYMASTER PREAMP

ALL NEW

The Playmaster Pro Series range of high-quality hi fi gear- the Pro Series Four reference premap. Developed from the respected Pro Series Two control preamp, this new design offers a larger number of features including infrared *remote volume control*, an even simpler construction method, and as before, first-class performance. ***EA DEC '96***

## PC-DRIVEN ARBITRARY & FUNCTION GENERATOR

ALL NEW

Need to generate signals with special formwaves, for testing? Here's the design for a PC-driven unit that will cost you much less than commercial function of arbitrary waveform generators, but can produce signals of virtually any desired waveform at frequencies from 0.25Hz to beyond 100kHz. ***EA DEC '96***

## LOW COST POCKET SAMPLER

***EA AUG '96***

This compact PC-driven analog sampler requires no batteries or power supplies. It uses power from the PC, supplied to it via the parallel port. It allows you to monitor voltage changes over periods ranging from milliseconds to months.

## PC- DRIVEN ELECTROCARDIOGRAM

This simple project will let you take your own electrocardiograph, and display it on a PC. With the software supplied, you can read, display, save to disk and print the electrical waveform generated by your own heart (or anyone else's). Powered by a 9V battery and electrically isolated from the computer, the PC-ECG is a safe, low cost way to monitor the electrical activity of the heart. ***EA JULY '95***

## INFRA-RED STEREO AUDIO LINK

Our new Infra-red stereo link allows you to relax in your favourite armchair and listen to stereo sound at a level that suits you. Individual volume controls allow you set the left to right balance.***SC Sept '96***

## MODEL TRAIN CONTROL WITH SIMULATED INERTIA

This simple, low-cost train controller uses a very efficient phase control system to regulate the speed of your model train, giving better load-speed regulation. It also simulates inertia and momentum, making the train run much more realistically. Together with a couple of other features this makes the controller a worthwhile addition to almost any layout.

**EA OCT'95**

## SMART DUAL 12V BATTERY CONTROLLER

This auxillary battery manager takes full advantage of a dual battery setup's capabilities, by controlling when and how the "auxillary" battery is connected to the electrical system. It's fully automatic, will cost you far less than an equivalent commercial unit, and is particularly suited to the new breed of deep-cycle auxillary batteries.

**EA JAN'96**

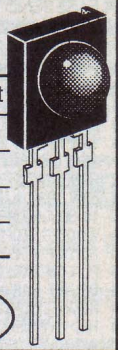
## STROBOSCOPIC TUNER MK3

This third incarnation of a cheap and simple device to help tune musical instruments uses standard-off-the-shelf components. It will tune over the full chromatic scale and covers a generous seven octave spread.

**EA May '96**

SCKIT197-NOV96S

## OPIC IR Sensor For Remote Control



**Features**

1. One package by OPIC technology
2. Compact (Approx. 1/6 in volume, as compared with the current model GP1U57X)
3. B.P.F. center frequency (fixed at 38kHz)
4. Special lens design

**Applications**

- Light detecting portion for remote control
  1. Audio equipment
  2. Compact AV equipments
- Optical switch

**Absolute Maximum Ratings** (Ta=25°C)

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Supply voltage | Vcc | 0 to 6.0 | V |
| *Operating temperature | Topr | -10 to + 60 | |
| Storage temperature | Tstg | -20 to +70 | °C |
| *2 Soldering temperature | Tsol | 260 | °C |

*1 No dew formation *2 For 5 seconds

ALL NEW

Z10443 **$5.95**

## BJC - 4200

• B&W text that's up to 168% faster; • Canon's unique new PhotoRealism; • Colour optimised for plain paper; • Up to 0.8 A4 colour pages per minute at 360 dpiBJC-4200 Full colour & high speed B&W •**Standard Print Head** BC-20: 128 nozzles for black, BC-21: 64 nozzles for black, 24 nozzles each for CMY •**Print Width**-Max. 293mm (8 inches) •**Print Speed**-With BC-21: Draft 255 cps, HQ 180 cps at 10 cpi. Colour 0.3 to 0.8 ppm for full A4 page; With BC-20 Draft 510 cps, HQ 360 cps at 10 cpi. Max 4.8 pages per minute •Up to 720 x 360 dpi (+ text smoothing with BC-20) •Automatic Feed (up to 100 sheets), Manual Feed •**Print Direction**-Text Bi-directional, Graphics Uni-directional •A4, A5, B5, Letter, Legal, DL Envelope, #10 Envelope, Plain, Coated, Water Resistant and Glossy Papers, Transparencies, High Gloss Film, Back Print Film, Fabric Sheet, T-shirt Transfer, Paper Weight 64 to 105 gsm •**Built-in Fonts** 6 built-in, 20 True Type fonts on disk • **Included Accessories**-Drivers for Microsoft Windows 3.1x/95 and MS-DOS, user guide and power cable, BC-20 cartridge, BC-21 cartridge, ink cartridge storage container• **Interface** Parallel - IEEE 1284 compatible C22420.....**$650** tax inc

## BJC - 4550

•Windows and Mac compatibility; •Printing in sizes up to large A3 •B&W text that's up to 168% faster; • Colour optimised for plain paper • Canon's unique new PhotoRealism;• a RRP less than half the nearest competitor! BJC-4550 A3 Apple & Windows compatible •BC-20: 128 nozzles for black, Bc-21: 64 nozzles •**Print Heads** for black, 24 nozzles each for CMY •**Print Width**-Max. 289 mm (11.4 inches) •**Print Speed**-With BC-21: Draft 255 cps, HQ 180 cps at 10cpi. Colours 0.3 to 0.8 ppm for full A4 page; With BC-20 Draft 510 cps, HQ 360 cps at 10 cpi •**Resolution**-720 x 360 dpi (+ text smoothing with BC-20) •Automatic Feed (up to 100 sheets), Manual Feed •**Print Direction**-Text Bi-directional, Graphics Uni-directional •**Buffer Size**-Input 64kb, Download 32kb •A3, A4, A5, B5, Letter, Legal, Tabloid, DL Envelope, #10 Envelope, Plain, Coated, Water Resistant and Glossy Papers, Transparencies, High Gloss Film, Back Print Film, Fabric Sheet, T-shirt Transfer (Paper Weight-64 to 105 gsm) •**Built-in Fonts**-6 built-in, 20 True Type fonts on disk •**Included Accessories**-Drivers for Microsoft Windows 3.1x/95, MS-DOS and Macintosh, user guide and power cable, BC-20 cartridge, BC-21 cartridge, ink cartridge storage container •**InterfaceParallel** - IEEE 1284 compatible, Apple-style RS-422 serial C22430.....**$895** tax inc

## Deluxe ANALOGUE MULTIMETER

Dekuxe analogue multimeter with most popular ranges. Ideal for students studying electronics or around the home when simple testing of electronics is required.

Specifications:
- 5 functions
- 20 measuring ranges
- 20000W/volt AC
- Single knob selector switch
- With test leads and manual
- Battery: 2 x AA (1.5 volts)

Ranges:
**DCV:** 0 - 1,2.5,10,25,100,1000
**ACV:** 0-10,25,100,250,1000
**Resist:** x1W, x10W, x100W, x1KW
**DC amps:** 5mA, 50mA, 500mA, 50μ, 500μ

Q91564 **$39.95**

**IDEAL FOR STUDENTS STUDYING ELECTRONICS COURSES!**

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Range includes The Complete Idiot's Guide to:

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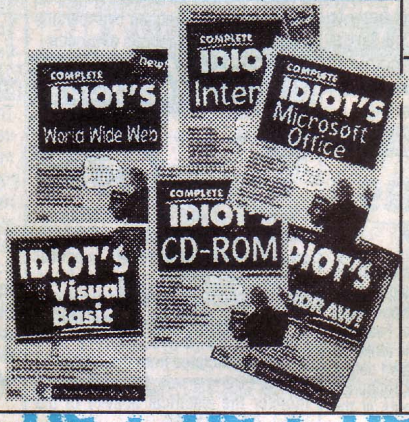


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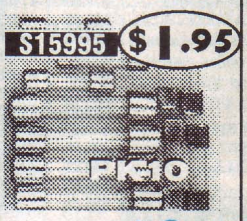


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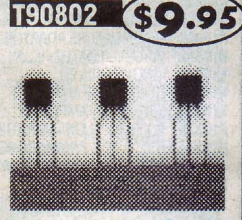


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### FUSE-M205

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SCNP1397-AUG 98

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| K10005 SOLAR VOLTAGE REGULATOR | $13.95 | $10.45 |
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| K10100 1.5V TO 9V DC CONVERTER | $11.95 | $8.95 |
| K10145 SCREECHER CAR ALARM | $36.95 | $27.70 |
| K10465 LOW COST 25W AMPLIFIER MODULE | $18.95 | $14.20 |
| K10570 COOLANT LEVEL ALARM | $29.95 | $22.45 |
| K10575 STEAM TRAIN WHISTLE & SIMULATOR DIESEL HORN | $22.45 | $16.83 |
| K10555 DUAL ELECTRONIC DICE | $24.95 | $18.70 |
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## MINI LAMINATOR

With the *LATEST MINI LAMINATOR*, you can protect and preserve your favourite documents - **up to 4" X 6" size,** business cards, recipes, membership cards, photos and other types of paper thin objects in a waterproof, airtight seal. The Laminator is designed with 4 rollers inside the body for high quality performance.

**Specifications-**

***Maximum Laminating Width:*** 110m/m
***Laminating Speed:*** 330mm/minute
***Laminating Temperature:*** 115°C (thermostat)
***Weight:*** 900g (N.W.)
***Size:*** 188 x 137 x 69 (mm)
***Power Source:*** 110-220 VAC (50-60 Hz)
***Power Consumption:*** 220 W

SAVE $20 WAS $89

NOW $69

### 80 MICRON POUCHES

Comes in sleeves of two sheets. Material are simply inserted into the pouch & put through the laminator

| Cat No. | Size | Price | QTY |
|---|---|---|---|
| A91110 | Credit Card | $12.95 | PKT 100 |
| A91113 | 95 X 135MM | $10.95 | PKT 24 |

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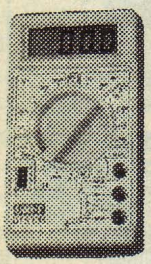
## DIGITAL MULTIMETER

The ideal meter for technicians with a full 3½ digit LCD readout. Requires a 9V battery either alkaline or carbon. Expected life of carbon battery is 100 hours and 200 for the alkaline.



Q13077

SPECIFICATIONS:

| | |
|---|---|
| DC Voltage: | 200mV/2/20/200/1000V |
| Basic accuracy: | +/-0.5% |
| Input Impedance: | 1M |
| Maximum Input: | 1000V DC |
| AC Voltage: | 200/750V |
| DC current: | 200A/2000A/20mA/200mA/10A |
| Resistance: | 200Ω/2000Ω/20kΩ/200kΩ/2M |
| LCD Display: | 15 x 46mm |
| Dimension: | 70 x 126 x 24mm |

1000'S SOLD

| 1-9 | 10+ |
|---|---|
| $19.95 | $17.95 |

## PULLOUTS/DAMAGED OLD MOTHERBOARDS

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HEAPS OF PARTS OR BUY 2 OR 3 TO GET GOING. SOLD AS IS.

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Supports P54CX family CPUs running at 75 - 200 MHz speeds, Cyrix 6x86 CPUs running at P120+/P133+/P150+/P166+, and AMD 5k86/K5 CPUs. Fully compatible with industry standards.

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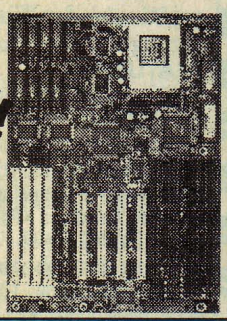

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## NEW COMPUTER POWER SUPPLIES PARTS

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| T90764 | *2SC4242* | $3.95 | $2.95 |
| T90757 | *2SC2810* | $3.95 | $2.95 |
| R15595 | *220uF 200Volt Electro* | $4.50 | $3.95 |
| Z10468 | *CBT34 Dual Diode* | $2.95 | $2.50 |
| U10156 | *TL494* | $2.95 | $2.50 |
| U11120 | *LM339* | $0.80 | $0.70 |
| T90318 | *BU508D* | $5.50 | $4.50 |
| T90330 | *BUZ90A* | $9.95 | $8.95 |

## CANNON TYPE CONNECTORS

| Cat No. | Product | 1-9 | 10-99 | 100+ |
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| | | NEW LOWER PRICES | | |
| P10960 | 3 Pin Line Male Plug | $2.95 | $2.50 | $2.00 |
| P10962 | 3 Pin Chassis Male | $2.50 | $2.00 | $1.50 |
| P10964 | 3 Pin Line Female Socket | $3.50 | $3.00 | $2.75 |
| P10966 | 3 Pin Chassis Female | $3.50 | $3.00 | $2.50 |

SCN-J97-NOV 98S

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# THE ROD IRVING ELECTRONICS PTY LTD

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## STEREO MICROPHONE HEADSET

A14044 $19.95

- 2.5 metre cord
- Adjustable boom
- Stereo plugs included for audio output and for listening

ALL NEW

## A4 LAMINATOR

ALL NEW

you can protect and preserve your favourite documents - **up to A4 size**, business cards, recipes, membership cards, photos and other types of paper thin objects in a waterproof, airtight seal.

A91101 $179 TAX INC $146.75 TAX EX

**Specifications-**

***Maximum Laminating Width:*** 230m/m
***Laminating Speed:*** 330mm/minute
***Laminating Temperature:*** 115°C (thermostat)
***Weight:*** 2100g (N.W.)
***Size:*** 375 x 245 x 88 (mm)
***Power Source:*** 110-220 VAC (50-60 Hz)
***Power Consumption:*** 260 W

## MINI LAMINATOR

A91100

ALL NEW

With the *LATEST MINI LAMINATOR*, you can protect and preserve your favourite documents - **up to 4" X 6" size**, business cards, recipes, membership cards, photos and other types of paper thin objects in a waterproof, airtight seal. The Laminator is designed with 4 rollers inside the body for high quality performance.

$89 TAX INC $79 TAX EX

**Specifications-**

***Maximum Laminating Width:*** 110m/m
***Laminating Speed:*** 330mm/minute
***Laminating Temperature:*** 115°C (thermostat)
***Weight:*** 900g (N.W.)
***Size:*** 188 x 137 x 69 (mm)
***Power Source:*** 110-220 VAC (50-60 Hz)
***Power Consumption:*** 220 W

### 80 MICRON POUCHES

Comes in sleeves of two sheets. Material are simply inserted into the pouch & put through the laminator

| Cat No. | Size | Price | QTY |
|---|---|---|---|
| A91110 | Credit Card | $12.95 | PKT 100 |
| A91111 | 111 X 171MM | $12.95 | PKT 24 |
| A91112 | 108 X 157MM | $10.95 | PKT 24 |
| A91113 | 95 X 135MM | $10.95 | PKT 24 |
| A91118 | 216 X 303MM (A4) | $99.00 | PKT 100 |
| A91122 | 216 X 303MM (A4) | $12.95 | PKT 10 |

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### The Compact Printer that is BIG on Performance

Ideal for small business or home users who need the highest standards of monochrome printing under Windows combined with fast throughput and excellent paper handling.

**FEATURES:**

•600 dpi resolution with MicroRes 600 •OKI microfine spherical toner - crisper characters •OKI LED technology- superior reliability and print quality •WYSWYG- what you see is what you get on the printed paper •100 auto paper sheet feeder •Manual feed for envelopes,irregular paper sizes and thickness •Paper size- A4, B5, A5. Letter, Legal, Executive •Envelope size- Monarch, COM-10, C5, DL•Toner cartridge- approx. 1,000 pages at 5% density •Drum unit-approx. 10,000 pages at 5% density •LED 4ppm page printer •23 seconds to first print •Fast return to application •Centronics bi-directional parallel interface

***IT'S A REAL CUTIE!***

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•HP LaserJet IIP (PCL 4.5) emulation via Windows DOS box.

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*Conditions apply

**FEATURES:** ELLCON MODEL

***•Modem protocol:*** ITU-T V.34/V.32bis/ V.32/ V.22bis/ V.22/ V.23/ V.21 Rockwell V.FCBELL 212A/ 103 ***•Fax protocol:*** ITU-T V.17/ V.29/ V.27ter /V.21 ch2, Group 3 compatible ***•Throughtput enhancement:*** MNP 10 ***•Error correction:*** MNP4 and ITU-T V.42 ***•Data compression:*** MNP 5/ ITU-T V.42bis /T4 ***•Software:*** *Data-* AT command compatible/ <V2.5bis Commands>/ Auto sync command *Fax-* EIA class I & II fax command ***•Call progress monitor:*** Speaker with software volume control ***•Transmission speed:*** 1200/ 2400/ 4800/ 7200/ 9600/ 12,000/ 14,400/ 16800/19200/ 21600/ 24000/ 26400/ 28800 bps full duplex, according to ITU-T V.22/ V.22bis/ V.32/ V.32bis/ V.34 Rockwell V.FC 115200 or 57600 bps

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- Captures video at up to 15 fps @ 320 x 240
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Includes:

- Video capture board
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| X18004 | IDE/SPG | $39 |
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| X18165 | 16bit ETHERNET RJ45 + BNC | $49 |
| X18169 | 16bit NE2000+ | $119 |
| X15810 | Ethernet 5-port 10 base T hub | $169 |
| X15814 | Ethernet HUB 10 base T Connector (8 RJ45 Effective) | $199 |
| X15816 | Ethernet HUB 16 base T Connector (14 RJ45 Effective) | $349 |
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| X18141 | High Speed Serial Card 1-Port 16550 | $49.95 |
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| C14260 | SMART GAMES Cont | $39.95 |
| X18514 | FULL -DUPLEX ISA **ETHERNET** | $99 |
| X18171 | Ethernet **Intel PnP** BNC/RJ45 16-bit | $199 |
| | *Ethernet **III Rev B Coax (BNC, AUI)** | $250 |
| X17396 | OEM SBlaster PnP Vibra 16 with IDE interface | $109 |
| X17394 | OEM SBlaster PnP Vibra 16 without IDE interface | $99 |
| X17398 | OEM SBlaster PnP Vibra 32 Sound Card | $209 |
| X17357 | OEM PhoneBlaster | $289 |
| X17250 | ESS 16 Bit Sound Card | $55 |

*SB OEM products do not have manual or connection cables*

****AVAILABLE TO ORDER***

| | | |
|---|---|---|
| | **VLB** | |
| X18003 | ENHANCED VESA MULTI I/O | $49 |
| X18050 | VESA IDE ENHANCED MULTI I/O- **PROMISE TECH** | $129 |
| X18195 | VESA VGA CARD | $149 |
| | **PCI** | |
| X17900 | PCI 1M VGA TRIDENT 9440 | $79 |
| X18206 | PCI VGA DIAMOND STEALTH 1MEG DRAM | $109 |
| X18207 | PCI VGA DIAMOND STEALTH 2MEG DRAM | $139 |
| X18208 | PCI VGA DIAMOND STEALTH 2MEG VRAM | $399 |
| X18209 | PCI VGA DIAMOND STEALTH 4MEG VRAM | $799 |
| X18218 | **New** OEM PCI Diamond Stealth 3D Video 2MEG | $199 |
| X18183 | PCI VGA CIRRUS LOGIC 5430 1MEG | $75 |
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| X18171 | FULL -DUPLEX PCI ETHERNET | $99 |
| X18150 | PCI Ethernet BNC/RJ45 | $79 |
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SCNP3J97-NOV96

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# ASK SILICON CHIP

**Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.**

## Query on knock frequency

A friend of mine recently purchased a Knock Indicator kit for his modified V8 Holden. Out of interest, I was reading the attached notes and, on doing the calculations for the knock frequency, found it to be 5.4kHz, which is above the cutoff of the 5kHz low pass filter.

Do you envisage this causing any problems with the circuit's operation? If so, what modifications would you recommend? Would you tighten the passband, knowing the engine's frequency? Is 800Hz to 5kHz a general span? Your thoughts would be appreciated. (G. W., Bendigo, Vic).

• The circuit as it stands will probably work OK even though the 5kHz filter will roll off some of the 5.4kHz knock signal. You could raise the 5kHz rolloff by changing the 18kΩ resistors for the low pass filter to 15kΩ and the 9.1kΩ resistor to 7.5kΩ. This will raise the cutoff frequency to 6kHz.

## PIR movement detector doesn't

I'm writing concerning the PIR Movement Detector in SILICON CHIP, November 1995. There is a fault I hope you could rectify for me. When I waved my hand in front of the sensor, LED1 flashes briefly (normal) but there is no output from IC1 pin 16 and no drive to Q4; therefore it cannot trigger the relay.

When I put a voltmeter probe or a screwdriver on pin 15 of IC1 at the same time my hand is moving in front of the sensor, it instantly triggers the relays and turns on a lamp I connected on the relay switch for about 3-30 seconds. It works perfectly every time something is moving for up to three metres in distance in front of the sensor, without touching pin 15 to set it up, but when I switch the unit off and turn it back on again, the fault reappears, until I touch pin 15 of IC1 to get it back to normal.

I measured +4.8V DC on pin 16 when it is working but that 4.8V is missing when it is not working, although LED1 was flashing every time something is moving in front of the sensor. Being a TV technician for the last 30 years, the first thing I did was to check the board to make sure there is no "man made fault". Of course, there isn't any. So I have come to the conclusion that either the IC is faulty or the circuit needs modification. (D. H., Fortitude Valley, Qld).

• From your description of symptoms it appears that the MPCC chip may be faulty. However, it may be possible to "save" it by connecting a 100kΩ resistor from pin 15 to pins 1 or 12. This pin is normally held high internally and it is possible that when you touch it with a screwdriver you pull it high. If this does not cure the fault we suggest that you obtain a replacement IC.

## Dimmer for halogen lamps wanted

I see that there is at least one commercial dimmer available for 12V quartz halogen lamps but they are quite expensive. Is there any chance that the SILICON CHIP team could come up with a suitable design? (A. W., Minto, NSW).

• As far as we know, Siemens do have an IC which is the basis for a halogen lamp dimmer. However, we are against the concept of dimming these lamps at all. If halogen lamps are to operate correctly, they must be run very close to the rated voltage of 12V. If they are operated at much less than 12V, which must occur if they are dimmed, the "halogen cycle" inside the bulb stops working.

In brief, a quartz halogen lamp has a small bulb made of quartz glass so that it can operate at a very high temperature. At the same time, a halogen such as iodine or bromine is added to the gas filling in the bulb and this is usually at a pressure of several atmospheres, leading to much brighter filaments. As the filament runs at such a high temperature, tungsten is evaporated and would normally be deposited on the bulb (leading to blackening and eventual failure). However the tungsten atoms are intercepted by two or more halogen atoms and the resulting molecule cannot be deposited on the bulb because it is too hot.

When the tungsten bromide (or iodide) molecule floats back into the region of the very hot filament, it disassociates and the tungsten is redeposited onto the filament and the halogen is released.

This regenerative process prevents the bulb from blackening and maintains the light output essentially con-

## Metal detector operating frequencies

Why do some metal detectors work on 71kHz while others work on 6 to 80kHz? Why not use microwave frequencies? Wouldn't they work deeper? (C. D., Victor Harbor, SA).

• As far as we are aware, most metal detectors operate at below 100kHz because these frequencies have been found to be most effective with typical search coil dimensions. Penetration is usually a function of the power of the metal detector's transmitter, the sensitivity of its detector coil and the overall dimensions of the coils; the larger, the better.

If microwaves were to be used they would require very high power levels to get deep penetration. We understand that microwaves are used for archeological surveys where quite deep penetration, up to several metres, is achieved but the system is not portable in the normal sense of the word.

stant throughout its life. Eventually though, the filament will develop weak spots and will fail.

As we understand it, if a halogen lamp is dimmed, it is not hot enough to allow the halogen cycle to provide the filament regeneration and so the bulb will blacken and the lamp will fail much earlier than it otherwise would have.

Quite frankly, we think that halogen lights are largely impractical for domestic use. They run very hot and while their light output is bright, it is very localised. Therefore, if you don't want a lot of shadows you need a lot of halogen lights to satisfactorily light a room. That leads to very high power consumption and a lot of heat produced in the room – a real problem in summer.

Apart from these drawbacks, halogen lights usually have at least some ultraviolet output. This is particularly dangerous to your eyes when halogens are used in desk lamps. In fact, we find it silly that people are covering up while out in the sun and then often happily expose themselves to halogen lights while indoors!

Have you thought of using conventional lamps which can be dimmed?

## Multimedia sound system compatibility

Would you confirm whether the Multimedia Sound System (SILICON CHIP, October 1996) is compatible with Roland, Ensoniq, and the new 18-bit Core Dynamics sound cards? The article doesn't indicate incompatibles but I notice that the photo on page 71 shows a Creative Soundblaster card, the most commonly bundled brand, at least in New Zealand.

Concerning serious hifi, I've read the article on the 175W "Plastic Power" amplifier (April 1996) but I have a query. I notice the authors say it's "suitable for use with musical instruments or for hifi applications" which bearing in mind the word "serious" is a little puzzling. I wouldn't have thought that Naim, for example would suggest using their equipment as band gear, or Fender the reverse.

You might say, "well, fundamentally, you could; it just depends on how you adjust for input (guitar, CD, phono, etc)". Still, I get the impression that quality hifi amplifier manufacturers and quality musical instrument amplifier manufacturers design for rather different ends; ie, anything other than an extraordinary (and expensive) multipurpose hybrid would be a compromise. Of course, the (classic) issue is, "forget the specs, what does it sound like?"

I would love to put together an excellent, cost effective, hifi kit system – powerful, fast, tight amplifiers for the bottom end and warm, lush valves for the mid and top, plus a quality active crossover. As you'll know, audio shops can charge the price of a house, literally, for this type of equipment.

Your Back Issues pages mention a couple of high watt Mosfet projects (the last in August this year) which might work for bass. I vaguely recall from years ago these transistors have rapid rise time/input-output switching characteristics. But have you published a valve or valve-IC project? (T. G., Warkworth, NZ).

• Our Multimedia Sound System card is compatible with any sound card, regardless of make or type. All it needs is line outputs from the sound card to work.

With regard to amplifiers for music systems, there is no inherent difference in design between high fidelity and musical instrument amplifiers. The practical differences in commercial amplifiers designed for music instruments is that the heatsinking may be larger, because of the more rigorous conditions of use and the power supply may be more rugged. Musical instrument amplifiers need to be very ruggedly built as well, to withstand the rigours of transport and handling by "roadies".

On some musical instrument amplifiers, the high frequency response may also be more curtailed than in hifi amplifiers and the low frequency response may have some shaping. Even so, the basic power amplifier configuration will be the same.

For upmarket hifi amplifiers, they may go to the trouble of specifying special capacitors and cables to meet the demands of the so-called audiophile market but the main reason for the very high prices are the brand names on the fancy front panels.

On that basis, any of the amplifier modules we have described is equally well suited to high fidelity or musical instrument use. Our benchmark for a high fidelity amplifier is that it should not cause significant degradation of the signal from a compact disc player. That means that it must have a very good signal noise ratio, very low harmonic distortion and excellent separation between channels.

With that thought in mind, we will not publish a valve hifi circuit. In our opinion the terms "valve" and "hifi" are mutually exclusive. **SC**

## Woofer stopper makes audible clicks

I've built the Woofer Stopper Mk2 as published in the February 1996 issue and I have the same clicking sound noted by a reader from Rowville, as featured in "Ask Silicon Chip" for May 1996.

I have fitted a 0.1µF capacitor as suggested between base and emitter of Q3 without any positive results; increasing to 47µF transformed it to buzzing with still some clicking. Can you suggest how I can get rid off these unwanted clicks completely? (P. P., Abbotsford, NSW).

• The clicking sound heard in the piezo transducers is associated with the sudden burst of signal applied to them. These sudden rise and fall times of the burst signal can be slowed down by using a capacitor between the base and emitter of Q3 so that the clicking sound becomes inaudible.

We found that 47µF was sufficient to completely remove the clicking, provided that the burst level is adjusted correctly using VR2. If the circuit is over-driven, the clicking sound is unavoidable. This is detailed in the testing section of the article.

The buzzing sound could be caused by the modulation frequency applied to the transducer. You can slow down this effect by increasing the 2.2µF capacitor at pin 6 of IC2b to a larger value. A 10µF electrolytic capacitor should be satisfactory. Alternatively, the 560kΩ resistor at pin 5 of IC5 could be increased to 1MΩ to reduce the range of frequency modulation.

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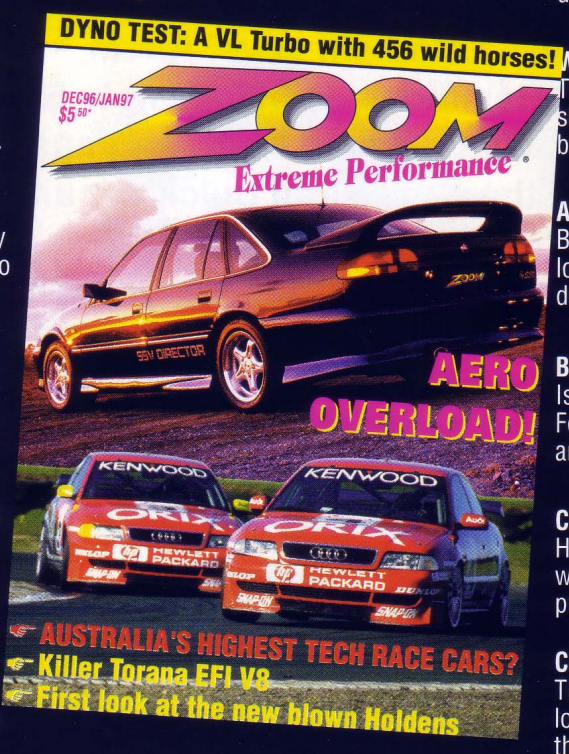


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